JAN 26 1911

January 24, 1911.

# POWER

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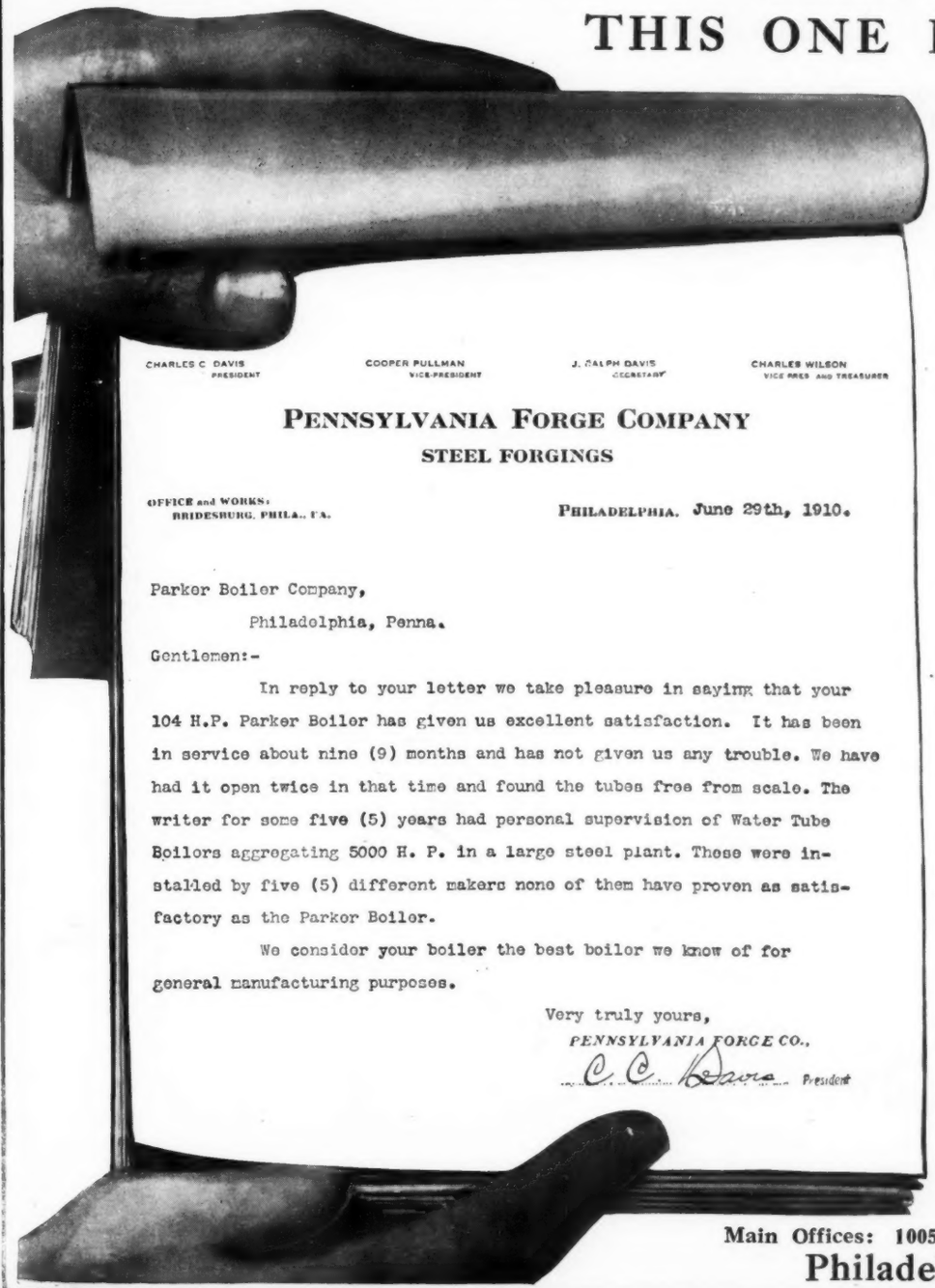
Index to Advertisers Follows Reading Matter


## BEFORE YOU OPEN THIS ISSUE READ THIS ONE LETTER!



CHARLES C. DAVIS, PRESIDENT — COOPER PULLMAN, VICE-PRESIDENT — J. RALPH DAVIS, SECRETARY — CHARLES WILSON, VICE PRES. AND TREASURER

**PENNSYLVANIA FORGE COMPANY**

**STEEL FORGINGS**

OFFICE and WORKS: BRIDESBURG, PHILA., PA.

PHILADELPHIA, June 29th, 1910.

Parker Boiler Company,

Philadelphia, Penna.

Gentlemen:-

In reply to your letter we take pleasure in saying that your 104 H.P. Parker Boiler has given us excellent satisfaction. It has been in service about nine (9) months and has not given us any trouble. We have had it open twice in that time and found the tubes free from scale. The writer for some five (5) years had personal supervision of Water Tube Boilers aggregating 5000 H. P. in a large steel plant. These were installed by five (5) different makers none of them have proven as satisfactory as the Parker Boiler.

We consider your boiler the best boiler we know of for general manufacturing purposes.

Very truly yours,

PENNSYLVANIA FORGE CO.,

C. C. Davis President

*The testimonials in this book we're showing here were received from Parker Boiler users during 1910.*

NOW

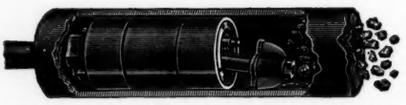
What we want to do is to send you our complete catalog, description, etc., of the Downflow Boiler principle, and back this theory up by sending you at the same time a copy of this book of letters stating the actual experiences of the engineers who have been proving the theory by actual practice during the last ten years or more. Write to us right now so we may send you these.

**Parker Boiler Company**

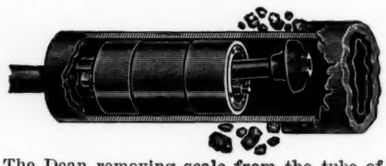
Main Offices: 1005 Pennsylvania Building

**Philadelphia, Pa.**

# The Dean Boiler Tube Cleaner



The Dean removing scale from the tube of a water tube boiler.



The Dean removing scale from the tube of a return tubular boiler.

removes scale from the inside or outside of boiler tubes—or condensers.

It is operated by air or steam and cleans 10 to 30 tubes an hour.

It operates on a mechanical principle that is sound—vibration.

It works a small vibrator which creates local vibration in the tube, thus causing the scale to lose its hold.

By changing this vibrator you can change the Dean from a Fire Tube Cleaner to a Water Tube Cleaner or vice versa.

Over 12,000 plants use the Dean.

For thoroughness of work, durability and range of work, there's no cleaner that will compare with it.

Suppose we send you one for free trial in one boiler.

Write for booklet 130, anyway.

# You Don't Guess At Weights When You Buy Coal—Why Guess At The Proper Methods Of Burning It?

Save it at one end to waste it at the other! That's what it amounts to.

Get the burning of coal down to a science and you'll get back $5.00 for every dollar you expend in doing your work scientifically.

Our *Flue Gas Analysis Instrument* gives a picture of the combustion conditions inside the furnace—shows where coal may be saved by changing the methods of firing or the draft regulation or by closing up leaks in the boiler setting.

It is practical, inexpensive and positive in results.

*Write for Catalogue.*

## The Wm. B. Pierce Co.

**Jewett Bldg., Buffalo, N. Y.**

**Chicago Office - 1201 Monadnock Bldg.**

# POWER

NEW YORK, JANUARY 24, 1911

WHY all this squealing, hissing, pounding, knocking and groaning? Why all these young clouds of steam, showers of oil and hot breezes bearing suggestions of scorched metal and burnt insulation? Why all the apparent confusion—is this a blast furnace?

No, this is not a blast furnace, this is an engine room.

You see, the engineer here is *getting results*. He has no time to put on "frills"—he is a *practical* man, he says, and glad of it. None of your nonsense about appearances for him.

He is too busy keeping the wheels turning to monkey with such details.

What if a joint or two is sprung or needs a new gasket! "Ain't" he delivering the goods?

What if the valves complain a bit and the engine booms every time it passes a center! "Ain't" he keeping the mill agoin'?

What if the stuffing boxes wheeze and squeak just a little? "Ain't" he furnishing all the power needed?

Two years ago he came here to get results—so he said. And, by the looks and sound of things, he *has* got them.

If a thing doesn't fit, he fits it—with a sledge. If a nut doesn't turn home as easily as it ought, he persuades it with a bigger wrench. He gets his results by the most direct methods.

This engineer is a "world beater"—you don't have to prove it, he admits it. He *knows* that he is always right. Was he not engaged to keep the machinery running? And has he not kept it running?

Economy? Nonsense!

A machine can do so much work. In order to do a certain amount of work the machine must have so much steam. It doesn't matter if a stuffing box leaks a bit or if a bearing or two is a little warm—set up on the box a little harder and run some water into the bearings. The amount of steam used is about the same in any case—he says so, and isn't he always right? Besides, the boilers are big enough anyhow. So, "let her rip."

He argues that to correct *little* defects such as those just mentioned would cost more than they are worth, not to mention the fact that it would cause him lots of bother and trouble, and take up too much of his time which is fully taken up as it is, getting results—and telling about it.

* * *

The foregoing concerns what may be termed a horrible example. Such an engineer does not realize that it is his duty not only to furnish power, but to furnish it as economically as he possibly can.

Genius has been described as the ability to take infinite pains; to be thorough, in other words.

In a given plant, that engineer is the best who can seek out and stop the greatest number of leaks and losses, no matter how small some of them may be. It is just as true in the power plant as it is anywhere else that if you take care of the cents the dollars will take care of themselves.

Wherever you are, whatever your duties, you are not making the best of your opportunities if you do not get results with the best economy that the equipment under your charge can be made to show.

# Hydroelectric Power at Wausau, Wis.

By D. B. Hanson

*A brief description of three small plants drawing their power from the waters of the Wisconsin river and the possibilities of further development.*

Slightly north of the geographical center of the State of Wisconsin, is situated, on the banks of the Wisconsin river, the town of Wausau, the county seat of Marathon county. The town has been built up largely on the lumber industry, and is still noted for the sawmills, tanneries and paper mills in its vicinity, which depend upon the forest products for a large share of their raw materials.

A portion of the power developed for these various industries is obtained from hydraulic plants situated on the Wisconsin river which, here, is capable of producing a head of about 25 feet, and is absorbed within the city limits by three installations.

The first of these, as shown on the map in Fig. 1, is McEachron's flour mill, situated on the west or main channel of the river. The mill is driven by single vertical turbines aggregating some 250 horsepower when operating under a 7-foot head, which is the maximum obtainable under the conditions prevailing at that point. The dam here is of the rock-filled timber-crib type and, while serving to maintain the head for this installation, also serves as a diverting dam for the other two, which are situated on the east fork of the river. At this point the river flows through several channels among a number of islands. The dam also serves for a spillway for the entire river in times of flood, there being no space provided at the dams of either of the other two developments for this purpose; to control the head in the eastern channels, a second dam has been built across their upper ends, thus converting these portions of the river into mere head and tail races, whose supply is determined by the regulation of the head gates in the second dam shown at the reference *E* in Fig. 1; the western channel is thereby made the main course of the river, only enough water being admitted to the east branches to supply the demands of the lower power houses which are situated about 1000 feet below the two dams above mentioned.

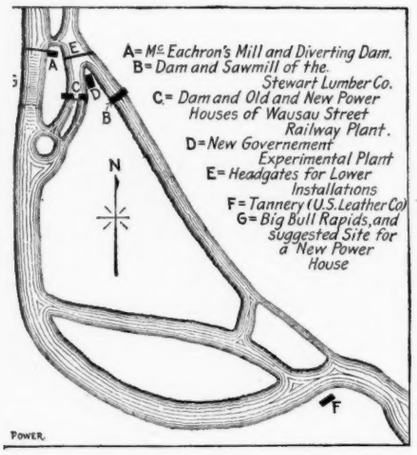

A= Mc Eachron's Mill and Diverting Dam.
B= Dam and Sawmill of the Stewart Lumber Co.
C= Dam and Old and New Power Houses of Wausau Street Railway Plant.
D= New Governement Experimental Plant
E= Headgates for Lower Installations
F= Tannery (U.S. Leather Co)
G= Big Bull Rapids, and Suggested Site for a New Power House
N
POWER.

FIG. 1. WISCONSIN RIVER NEAR WAUSAU

Plant No. 2, that of the Stewart Lumber Company, is the smaller of the lower installations and is equipped with three horizontal shaft turbines of 275 to 300 horsepower aggregate capacity when operating on a 14-foot head. It drives a portion of the lumber mill of this company, its head race being used also to float down the logs to the conveyers of the main mill. It is decidedly a surprise to the ordinary man, who, though well informed, is not familiar with the large scale upon which the sawmills of this district were wont to operate in their earlier days, to see the immense storage yards and thousands of feet of elevated platforms carrying the extensive system of tramways used by this company in transporting its finished products from its sawmill and planing mill, which, for many years, averaged a cut of 30 million feet per season.

The third installation, that of the Wausau Street Railway Company, equipped with two independent turbine units and an auxiliary steam plant, is the largest of the three and operates under the highest head. It consists of two sections known as the old plant and the new. The old plant is a fair example of what one might expect to find in a plant which started in a very small way and was gradually enlarged to meet the increased demand for the electrical service which the plant supplies. This plant consists of a quadruplex horizontal turbine of Leffel make, which is direct connected to a line shaft driving two main generators, each of 350 kilowatts capacity, one generating current at 2200 volts, the other, being installed later, generating at 2300 volts. Both machines were originally two-phase, 60-cycle units operating at 150 revolutions per minute, but were later rewound to generate three-phase current. This new arrangement naturally resulted in a decreased output and a high overload upon the exciters, of which there are two 30-kilowatt machines, each belted to the main shaft of a generator.

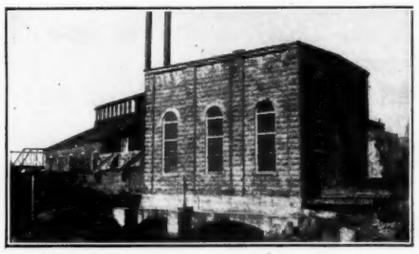


FIG. 4. OLD AND NEW WAUSAU PLANTS

The two generators are operated in parallel, and considerable trouble has been experienced. These units will shortly

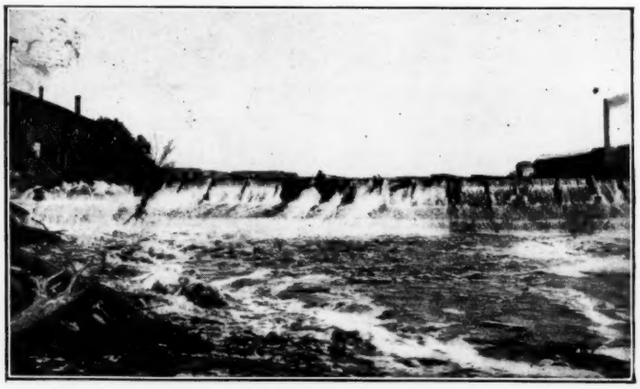


FIG. 2. MCEACHRON'S MILL DAM

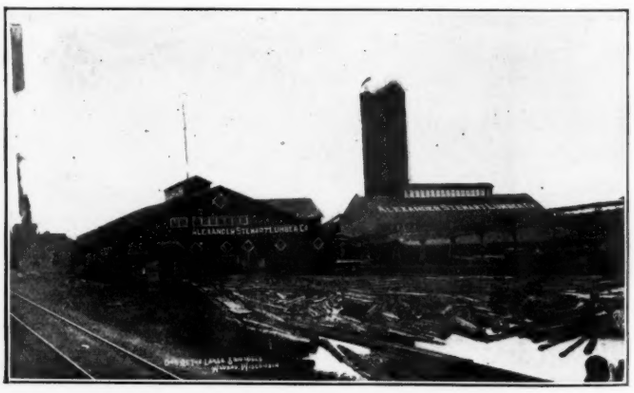


FIG. 3. HEADRACE OF STEWART LUMBER COMPANY

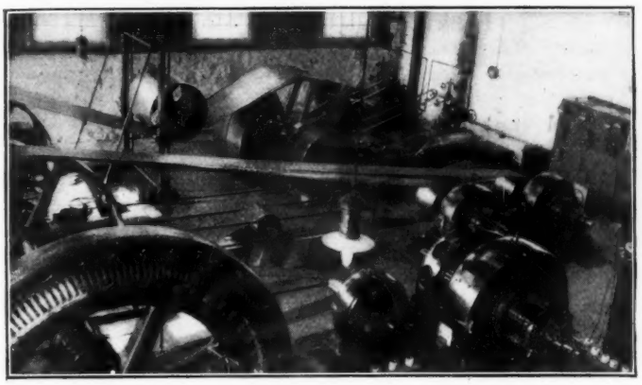


FIG. 5. OLD WAUSAU PLANT

FIG. 6. SWITCHBOARD CORNER OF OLD PLANT

be changed back to generate two-phase current, and their output will be transformed to three-phase before being sent out on the transmission lines. The electrical load of this station consists of factory motors, incandescent and arc-lighting and street-railway load, the latter being very severe in its fluctuations. nally handled by means of two 100-kilowatt direct-current Westinghouse generators, belt driven from a line shaft. Later, as these machines became inadequate, a 300-kilowatt motor-generator set was installed, the motor taking three-phase current at 2300 volts from the main generators. A number of 50-horse-power pump motors, installed in a paper mill some five miles away, still further complicate the fluctuations of load, as they have no starting boxes, and their starting current, when they are cut in directly across the line, is naturally heavy.

The usual switchboard apparatus, which serves both plants, completes the hydroelectric installation in the old plant, and a twin simple noncondensing slide-valve 18x30-inch engine with its battery of boilers comprises a means of driving the main line shaft through a friction clutch, in cases of low water or other emergencies which would cripple the hydraulic plant. This old plant with its machinery poorly chosen for its ultimate use became overloaded by the constantly growing demand in the town for electrical energy, and a new plant to supersede it became necessary. The new power house contains uptodate machinery of sufficient capacity to meet the

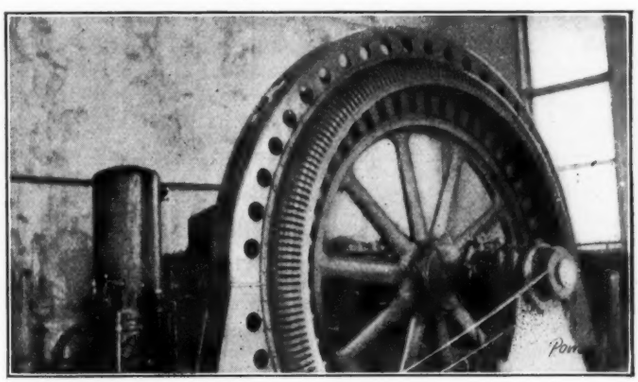


FIG. 7. MAIN GENERATOR IN NEW WAUSAU PLANT

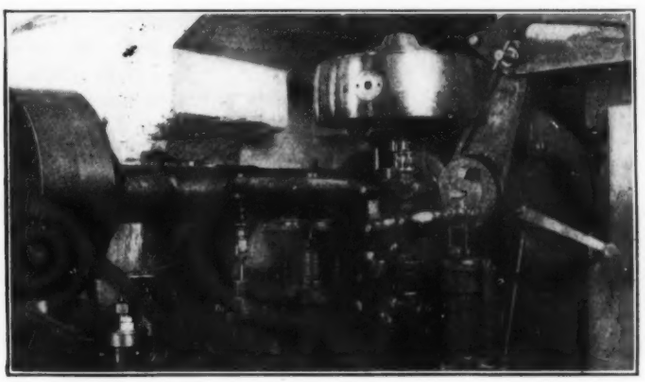


FIG. 8. OIL-PRESSURE GOVERNOR OF MAIN UNIT

On account of the small number of cars operating, it is comparatively easy to have nearly the whole system at rest or starting all at the same time, thus making the change from no load to the heaviest accelerating load occur in a very short space of time, often not more than ten seconds. This street-car load was origi-

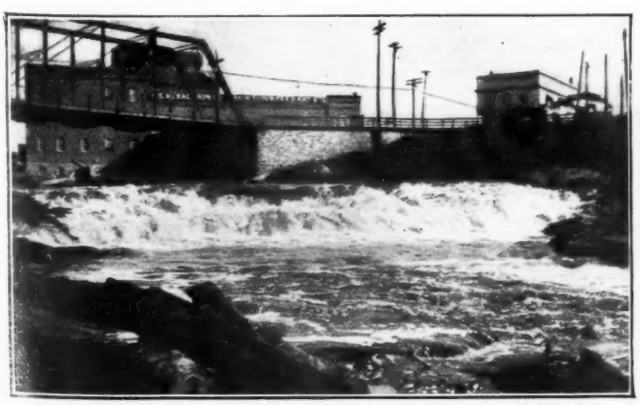


FIG. 9. BIG BULL RAPIDS AT TIME OF AVERAGE FLOOD

FIG. 10. TAIL RACE OF TWO WAUSAU PLANTS

present load, with a generous margin. It is built of cement block and is approximately 35x40 feet. The machinery installed consists of a quadruplex horizontal-shaft turbine, with 45-inch runners arranged in pairs and discharging into a common concrete draft tube. This unit is rated at 1700 horsepower at 150 revolutions per minute when operating under a 20-foot head. It is direct connected to a 900-kilowatt alternator, generating three-phase 60-cycle current at 2300 volts. A twin-turbine-driven exciter unit furnishes current for excitation. Both units are controlled by oil-pressure governors which are so connected to the wicket gates of the turbines as to eliminate the possibility of any lost motion occurring, the resultant regulation obtained being exceptionally good.

The present plan is to operate the new station at all times, holding the old plant in reserve for emergencies, and the steam plant for times of low water when the head races are fouled by large amounts of sawmill refuse and driftwood. Due to the close proximity of the several mills, this is very troublesome, as no means of ridding the forebays of this trash, except unwatering them and cleaning them by ordinary hand labor, are provided.

Taken collectively, the installations at Wausau show a chance for considerable improvement in the engineering details; the dam at McEachron's mill leaks badly, thus wasting power which in a dry season cannot be well spared. Further, its low head of 7 feet allows but a small amount of the natural power easily obtainable to be absorbed. At the sawmill of the Stewart Lumber Company, the head is still much too low, as a proper location of the installation could easily double the head used, while at the Wausau Street Railway Company's plant the normal head of 22 feet still falls at least 25 per cent. short of the possibilities of the situation.

Referring to the map, Big Bull Rapids, indicated at *G*, is an ideal location for a hydroelectric plant. The river here flows between banks at least 50 feet high and 600 feet apart over a solid rock bottom composed of a tough, brown granite, and at normal flow for nine months in the year at least 1000 kilowatts yet remains to be developed. This location would give ample room for proper forebays, and would also provide a chance for spillways that would readily take care of the large quantities of driftwood that now form such a disturbing and annoying factor in the operation of the present plants. It would provide the finest of foundations for a dam, and, last but not least, would increase the head from 30 to 400 per cent. of that used by the existing plants. It would also permit of the whole flow of the river being utilized, while now but a small part can be used in times of high water. In fact, the advantages are so many and so obvious that one can scarcely discern a reason for the neglect of the opportunity, and with the growth of the demand for power at this point it would seem that a plant must eventually be erected on this site.

In view of the agitation now prevailing over the question of conservation of our forest and other natural products, and the growing scarcity of pulp woods which are largely utilized by a large number of paper mills in this section of Wisconsin, it would seem but fitting to mention in this connection the experiment station now being erected by the United States Government at *D* in Fig. 1. This plant is being installed with the idea of conducting an exhaustive series of tests to discover methods which will permit of new varieties of timber being used in pulp making and will thereby, it is hoped, open up new fields of raw material to supplement those now being rapidly exhausted by present operations. This plant will absorb in its motors some 500 horsepower, which will be largely furnished by the street-railway company, and will load the plant to its fullest capacity.

# Keeping Power Plant Records

By Warren O. Rogers

*A most complete system of daily and monthly reports which show at a glance the cost of fuel, wages and any charge that should be credited to the cost of operation.*

The one way of knowing what a power plant is doing is to keep a suitable set of records, so that it can be known at any time just what the cost of operation is or has been, not only as to the cost of fuel, upkeep and wages, but of other

RECORD FOR ..... 19..

Kind of Coal .....

Quality .....

COAL—Day run ..... lbs. ..... Fireman.

Night run ..... lbs. .....

Total ..... lbs.

ASHES—Day run ..... lbs.

Night run ..... lbs. } % Ash .....

Total ..... lbs.

Water evaporated 24 hours .....

Pounds water to one pound coal .....

Current generated ..... K. W.

REMARKS:

FIG. 1.

charges that should be credited to the cost of plant operation. It is not a simple matter to get up a set of report sheets that will exactly fit individual conditions, the tendency being to border on the incomplete, rather than overdoing matters in recording power-plant data.

Keeping records does require considerable time on the part of the engineer and, for this reason, many fail to take a right view of the matter, contending that it is the business of the office to keep track of the power-plant costs.

There are engineers, however, who believe that it is their business to keep the records of the plant, not only so that a monthly report can be submitted to the manager, but for their own satisfaction and protection. Among the latter is Asa P. Hyde, chief engineer in the building of the Security Mutual Life Insurance Company, Binghamton, N. Y. A set of report sheets, gotten up and kept by Mr. Hyde, consist of daily, weekly and monthly reports.

The daily reports are used as a check on everything that occurs in the plant, and have much to do with the results obtained. A second factor is good help, all working together for the one purpose of seeing how much and how cheaply the work can be done.

The coal man takes quite an interest in the daily-record sheet shown in Fig. 1. This report and the chart from the recording steam gage are filed daily in a glass case in the boiler room for the inspection of the men. As the plant operates day and night, the report of both the day and night firemen are put on the same card. Each fireman, one for each watch, records the number of pounds of coal burned during the time he is on duty, also the weight of ashes made during his run. The percentage of ash obtained is what interests the coal dealer, and the knowledge that an ash record is kept, as well as a record of the amount of water evaporated per

**Ash Ticket.** _____ 190

| CARS FILLED. | FIREMAN. | CARS TAKEN. | CARTMAN. |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

FIG. 2.

pound of coal, tends to keep the quality of coal up to the standard. No. 1 buckwheat coal is burned and must not contain more than 16 per cent. of ash. Other fuels and sizes have been carefully

—DAILY—
COAL TICKET.

191

| 6 A.M. to 6 P.M. | | 6 P.M. to 6 A.M. | |
|---|---|---|---|
| LBS. COAL. | LBS. ASHES. | LBS. COAL. | LBS. ASHES. |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Fireman. Fireman.

Kind of Coal_____.
Coal Used _____Lbs.
Ashes Made_____Lbs.
% Ashes _____Lbs.
Water Used _____ Gals.
Water Used _____Lbs.
Water____Lbs. to 1 Lb. Coal.
Boiler Water Test Good - Med. - Low.

Power

FIG. 3.

No._____. _____, 190___.

DYNAMO REPORT SHEET.

| DAY. | Amperes. | NIGHT. | Amperes. |
|---|---|---|---|
| 6:30 A. M. | | 6:30 P. M. | |
| 7:00 " | | 7:00 " | |
| 7:30 " | | 7:30 " | |
| 8:00 " | | 8:00 " | |
| 8:30 " | | 8:30 " | |
| 9:00 " | | 9:00 " | |
| 9:30 " | | 9:30 " | |
| 10:00 " | | 10:00 " | |
| 10:30 " | | 10:30 " | |
| 11:00 " | | 11:00 " | |
| 11:30 " | | 11:30 " | |
| 12:00 M. | | 12:00 M. N. | |
| 12:30 P. M. | | 12:30 A. M. | |
| 1:00 " | | 1:00 " | |
| 1:30 " | | 1:30 " | |
| 2:00 " | | 2:00 " | |
| 2:30 " | | 2:30 " | |
| 3:00 " | | 3:00 " | |
| 3:30 " | | 3:30 " | |
| 4:00 " | | 4:00 " | |
| 4:30 " | | 4:30 " | |
| 5:00 " | | 5:00 " | |
| 5:30 " | | 5:30 " | |
| 6:00 " | | 6:00 " | |

REMARKS:

FIG. 7.

tested, but it has been found that more current can be produced at less expense with No. 1 buckwheat coal than

FIREMENS' REPORT.

Quality Coal, Day, Describe.....
" " Night "
If Clinker, Day, "
" Night, "
If Fires Build up, Day " Night
Shook or Cut Fires, Day..... Times. Night..... Times
Steam drop, Day, Why..... Night, Why.....
Draft, Day.....Good. Med. Poor. Night..... Good Med. Poor.
Load, Day..... Heavy. Med. Light. Night..... Heavy. Med. Light.
Live Steam Used, Day.....hrs. Night.....hrs. Weather .....
Condition of Apparatus and Wants.....

FIG. 4.

from any other, if it is carefully handled, as is done in this plant.

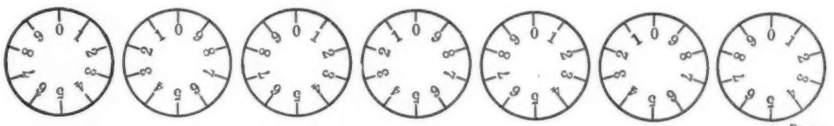
The ash ticket, Fig. 2, looks simple, hardly worth bothering about, but it prevents the cost of cartage of refuse from the building being charged up to the cost of power-plant operation. For instance, if the firemen get four cans of ashes per day and the cartmen remove six cans of ashes and refuse the cost of removing six cans would ordinarily be charged up against the plant, when the cost of removing two cans of refuse should have been charged against the building. The ash ticket prevents this and the charges for cartage are correctly made.

Figs. 3 and 4 show both sides of the daily coal ticket which is filed with the chief engineer. One side shows the kind and amount of coal burned and ashes obtained by each fireman from 6 a.m. to 6 p.m. and 6 p.m. to 6 a.m., also the amount of water used in gallons and pounds, and the amount of water evaporated per pound of coal with boiler-water tests.

The reverse side of the ticket contains the fireman's reports of the quality of the coal used, how it burns, whether the fires have been worked during a shift and other items that might shed light on the performance of the plant.

Water-meter readings are recorded on a card similar to that shown in Fig. 5. Fig. 6 is used for recording the total output of electrical energy to the various tenants.

WATER METER READING. _____, 190___.



Power

Present Reading_____
Previous Reading_____
Consumption _____
Carnegie Library Bk. Pressure_____
Carnegie Library Live Steam Day_____ Night____
Evaporation _____Lbs. to 1 Lb. of Coal.
Vacuum_____ Bk. Pressure Lbs.____Temp. Boiler Feed____
Temp. Hot Water Block _____°
Live Steam Block Days_____ Nights _____

FIG. 5.

No._____ METER READING. _____190___

Customer_____

K. W. Hour Consumption_____. Rate_____. Total, $_____

Power.

FIG. 6.

The daily dynamo-report sheet is shown in Fig. 7, the number of amperes carried being recorded each half hour, this being done to check the peaks and for charts if wanted later.

All renewals, repairs and new work about the building are performed by the engine-room force, but their time is credited to the plant. For instance, if a tenant of an office desires changes made in the arrangement of lights, or anything else, the man put to work making the alterations files the report shown in Fig. 8. It includes by whom the work was ordered, also the labor and material used, the cost of each being recorded. From this report sheet the work slip, Fig. 9, is filled out and the signature of the tenant is affixed thereto, as all material and supplies remain the property of the Security Mutual building. In case the tenant moves he must leave all fixtures, charged up to him over his signature.

Fig. 10 shows the engine and pump report which indicates when the various units were started, how long they were in operation and when shut down, also all work done on them and the materials used. This is all of the daily-report cards and from them the weekly report is compiled.

Workman_____ Ordered by_____ No.____

*To* *Date* *19*

| LABOR. | | | | MATERIAL. | | | |
|---|---|---|---|---|---|---|---|
| | Hours. | Rate. | Amount. | ITEMS. | Quantity | Rate. | Amount. |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | TOTAL.. | | | | TOTAL.. | |

*Labor*.....
*Materials*.....
*Total*.....

*REMARKS:*

FIG. 8.

WORK SLIP No._____
Security Mutual Building.

_____ 19____

Office No._____ Mr._____

To_____ Desk Lamp No._____ $_____

" _____ " " " _____ "

"

Changing—Adding—Renewals— $_____

WORK: _____ hours @ _____ per hour. _____

MATERIALS USED: _____ $_____

$_____

$_____

The above work has been performed at the request of the undersigned, and the material and articles above described are the property of Security Mutual Life Insurance Co., and will be returned to said Company in good condition at the termination of lease or removal from said office. Any materials or articles not returned to be charged to and paid by the undersigned.

_____
*Tenant*

FIG. 9.

For instance, Fig. 11 shows the weekly report of the amount of coal burned, ashes made, water used, kilowatts generated and the total number of elevator trips made during the week.

Expenses for the month for the plant, block and elevators are tabulated on the sheet shown in Fig. 12. The data found on the expense sheet for the month of October were taken from the workman's daily-report sheet shown in Fig. 8. The monthly expense report shows at a glance when the work was done and what material was used and to what department of the building it has been charged.

A more complete power-plant expense sheet is shown in Fig. 13. It designates the expenses for the month and what they were for; it is made up of five departments, as shown in the margin. The items having a check mark are charged to the operating expenses of the plant, but they should not be as they are of foreign character and are carried by the plant as a matter of convenience.

Data relating to the machinery of the plant are kept on a report sheet ruled as shown in Fig. 14. Here the daily record is tabulated and the items not filled in with daily readings are entered monthly.

A fuel-evaporation report sheet for October, November and December, 1910, is shown in Fig. 15, the month of October only being tabulated. These reports also

No._____ _____, 190____

ENGINE AND PUMP REPORT.

| DAY | Engine 1. | Engine 2. | Engine 3. | Comp. P. | Elect. 1. | Elect. 2. | Jack. | S. House. | Elect. "L. | Elect. "S. | Vac. 1. | " 2. | B. F. 1. | B. F. 2. | Air C. | Sump. 1. | " 2. | Trips 1. | Trips 2. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 A.M. | | | | | | | | | | | | | | | | | | | |
| 7:00 " | | | | | | | | | | | | | | | | | | | |
| 7:30 " | | | | | | | | | | | | | | | | | | | |
| 8:00 " | | | | | | | | | | | | | | | | | | | |
| 8:30 " | | | | | | | | | | | | | | | | | | | |
| 9:00 " | | | | | | | | | | | | | | | | | | | |
| 9:30 " | | | | | | | | | | | | | | | | | | | |
| 10:00 " | | | | | | | | | | | | | | | | | | | |
| 10:30 " | | | | | | | | | | | | | | | | | | | |
| 11:00 " | | | | | | | | | | | | | | | | | | | |
| 11:30 " | | | | | | | | | | | | | | | | | | | |
| 12:00 M. | | | | | | | | | | | | | | | | | | | |
| 12:30 P.M. | | | | | | | | | | | | | | | | | | | |
| 1:00 " | | | | | | | | | | | | | | | | | | | |
| 1:30 " | | | | | | | | | | | | | | | | | | | |
| 2:00 " | | | | | | | | | | | | | | | | | | | |
| 2:30 " | | | | | | | | | | | | | | | | | | | |
| 3:00 " | | | | | | | | | | | | | | | | | | | |
| 3:30 " | | | | | | | | | | | | | | | | | | | |
| 4:00 " | | | | | | | | | | | | | | | | | | | |
| 4:30 " | | | | | | | | | | | | | | | | | | | |
| 5:00 " | | | | | | | | | | | | | | | | | | | |
| 5:30 " | | | | | | | | | | | | | | | | | | | |
| 6:00 " | | | | | | | | | | | | | | | | | | | |

REMARKS:

| NIGHT. | Engine 1. | Engine 2. | Engine 3. | Comp. P. | Elect. 1. | Elect. 2. | Jack. | S. House. | Elect. "L. | Elect. "S. | Vac. 1. | " 2. | B. F. 1. | B. F. 2. | Air C. | Sump. 1. | " 2. | Trips 1. | Trips 2. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 P.M. | | | | | | | | | | | | | | | | | | | |
| 7:00 " | | | | | | | | | | | | | | | | | | | |
| 7:30 " | | | | | | | | | | | | | | | | | | | |
| 8:00 " | | | | | | | | | | | | | | | | | | | |
| 8:30 " | | | | | | | | | | | | | | | | | | | |
| 9:00 " | | | | | | | | | | | | | | | | | | | |
| 9:30 " | | | | | | | | | | | | | | | | | | | |
| 10:00 " | | | | | | | | | | | | | | | | | | | |
| 10:30 " | | | | | | | | | | | | | | | | | | | |
| 11:00 " | | | | | | | | | | | | | | | | | | | |
| 11:30 " | | | | | | | | | | | | | | | | | | | |
| 12:00 M. | | | | | | | | | | | | | | | | | | | |
| 12:30 A.M. | | | | | | | | | | | | | | | | | | | |
| 1:00 " | | | | | | | | | | | | | | | | | | | |
| 1:30 " | | | | | | | | | | | | | | | | | | | |
| 2:00 " | | | | | | | | | | | | | | | | | | | |
| 2:30 " | | | | | | | | | | | | | | | | | | | |
| 3:00 " | | | | | | | | | | | | | | | | | | | |
| 3:30 " | | | | | | | | | | | | | | | | | | | |
| 4:00 " | | | | | | | | | | | | | | | | | | | |
| 4:30 " | | | | | | | | | | | | | | | | | | | |
| 5:00 " | | | | | | | | | | | | | | | | | | | |
| 5:30 " | | | | | | | | | | | | | | | | | | | |
| 6:00 " | | | | | | | | | | | | | | | | | | | |

REMARKS:

FIG. 10.

*Total for Week Ending*_____, 190__

AMPERES:— Low_____ High_____

| COAL—Day. | | COAL—Night. | |
|---|---|---|---|
| Sun | Total and averages for day of 24 Hours | Sun | Total and Evaporation figured here |
| Mon | | Mon | |
| Tues | | Tues | |
| Wed | | Wed | |
| Thur | | Thur | |
| Fri | | Fri | |
| Sat | | Sat | |

| ASHES. | | WATER. |
|---|---|---|
| Sun | Total and ⅒ figured here | Last Reading |
| Mon | | Previous Reading |
| Tues | | **Total K. W.** |
| Wed | | Last Reading |
| Thur | | Previous Reading |
| Fri | | **Power K. W.** |
| Sat | | Last Reading |
| | | Previous Reading |

**ELEVATOR TRIPS.**

| | No. 1. | No. 2. |
|---|---|---|
| Sun | | |
| Mon | | |
| Tues | | |
| Wed | | |
| Thur | | |
| Fri | | |
| Sat | | |
| TOTAL | | |

FIG. 11.

contain the monthly switchboard reading. The readings of all items are the totals of the weekly reports.

A comparison of the corresponding three months for three years is recorded on the card shown in table form. The totals are given for each month for coal, loads in kilowatt-hours and elevator trips. In the margin is recorded the increase in coal used one year over another, and per cent. the increase in output.

THREE MONTHS DATA OF 1907, 1908 AND 1909.

| Date. | Coal. | Load Kilowatt-Hours. | Elevator Trips. | |
|---|---|---|---|---|
| 1907 | | | | |
| October | 221,269 | 23,890 | 21,947 | Used 25,246 pounds more coal 1909 than in 1908 and generated 13,350 kilowatt-hours more current. |
| November | 223,371 | 21,010 | 21,127 | |
| December | 225,669 | 25,530 | 21.641 | |
| Totals | 670,309 | 70,430 | 64,715 | |
| 1908 | | | | |
| October | 210,185 | 29,150 | 22,045 | Increase in fuel used in 1909 over 1908 $3\frac{5}{10}$ per cent. Increase in kilowatts output 14 per cent. |
| November | 214,731 | 30,000 | 19,997 | |
| December | 222,980 | 33,090 | 21,193 | |
| Totals | 647,896 | 92,240 | 63,235 | |
| 1909 | | | | |
| October | 212,018 | 33,910 | 21,385 | Increase in fuel used 1909 over 1907, $\frac{1}{10}$ of 1 per cent. Increase in kilowatts output 33 per cent. |
| November | 222,094 | 34,910 | 21,139 | |
| December | 239,033 | 36,770 | 22,614 | |
| Totals | 673,145 | 105,590 | 65,138 | |

Took on additional load from "Phelps Building," September 18, 1908.
Carnegie Library taken on October 20, 1909, consisting of lighting, heating and hot-water service.

At the bottom of this sheet remarks are entered which may have any bearing on any increase or decrease in coal consumption during the year.

Referring to the bottom of the record sheet, Fig. 13, it is shown that $640.53 has been charged up against the plant for operating expenses and an income of $1345.20 from the electrical output, making a profit of $704.67 per month, a large profit for a $15,000 investment, the cost of the plant. During the six years that this plant has been in operation it has never been run at a loss.

Details relating to the plant and the method of operating it will be published in another article. It is through the courtesy of the chief engineer, Asa P. Hyde, that the data and accompanying report blanks have been obtained.

## Power from the Sun and Wind

Next to discovering perpetual motion, probably one of the most alluring fields for experiment on the part of scientists in search of great reward is that of utilizing the radiant-heat energy of the sun and the kinetic and potential energy of the wind and waves. The problem of converting the energy from these sources into a form which is suitable for commercial use is extremely complicated and, so far, has baffled complete solution. Of course, windmills have been successfully used for centuries in the performance of certain kinds of work, principally that of pumping water. However, the power derivable from a windmill, depending as it does on the variable weather conditions, would not be suitable for driving an electric generator connected directly to the mill because the apparatus would be dead still in a calm and working very much "overtime" whenever a gale happened to be blowing. Hence, no dependence could be placed on any forecast of the quantity of power to be obtained at a given time.

It has often been proposed to have the windmill work a pump to raise water from one reservoir to another, say, 1000 feet above the first, at whatever rate the winds will drive the mill; then, to allow the water to flow back into the first reservoir at a given steady rate of flow, and, in so doing, operate a waterwheel-driven dynamo. For such a scheme to be suc-

No. 10 Expenses for Oct 1910

| | | | | PLANT. Additions. | | | PLANT. Maintenance. | | | BLOCK. Additions. | | | BLOCK. Maintenance. | | | ELEVATORS. Additions. | | | ELEVATORS. Maintenance. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Work and Workman | Ticket No. | Hours Total. | Hours. | Labor. | Materials. | Hours. | Labor | Materials. | Hours. | Labor. | Materials | Hours | Labor | Materials. | Hours. | Labor | Materials | Hours. | Labor. | Materials. |
| 1 | Sealey Plant B.O.P. No 1 | 1 | | | | | | | .08 | | | | | | | | | | | | |
| | " " Pump No 2 | 2 | | | | | | | 2.3 | | | | | | | | | | | | |
| | Hand soap | | | | | | | | .05 | | | | | | | | | | | | |
| | Cleaner | | | | | | | | .10 | | | | | | | | | | | | |
| | Common Soap | | | | | | | | .15 | | | | | | | | | | | | |
| 3 | Sealey Security | 4 | 1/2 | | | | | | | | | | 1/2 | .20 | .05 | | | | | | |
| | " Block | 5 | 1/2 | | | | | | | | | | 1/2 | .20 | .53 | | | | | | |
| | " Plant B.O.P No 2 | 6 | | | | | | | .32 | | | | | | | | | | | | |
| 9 | Hyde Elevators 1-2 | 20 | 3/4 | | | | | | | | | | | | | | | | 3/4 | .30 | .72 |
| 10 | Sealey Block | 21 | 1/2 | | | | | | | 1/2 | .20 | .10 | | | | | | | | | |
| 11 | " " | 24 | 2 | | | | | | | 2 | .80 | 3.52 | | | | | | | | | |
| 21 | Hyde Plant | 38 | 3 | 3 | 1.20 | 2.59 | | | | | | | | | | | | | | | |

Time only in distributions charged, as all time goes in as against the Plant has outside work on Block and Elevators.

FIG. 12.

No. 10 **POWER PLANT EXPENSE SHEET** Oct. 1910.

**BOILERS H. P. STEAM AND EXHAUST LINES.**

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coal | 206365 | Lbs. | $ 2.85 | per Ton. | | | | | | | | | | | | | 2 | 5 | 4 | 9 | 0 |
| Carting Ashes | 18 | Loads | .35 | per Load. | "Emens" | | | | | | | | | 6 | 6 | 5 | | | | | |
| Boiler Compound | 111 | Lbs. | .12½ | per Lb. | Kind. Dearborn using heavy | | | | | | | | 1 | 3 | 3 | 2 | | | | | |
| City Water | | "Plant only." | | | | | | | | | | | 1 | 0 | | | | | | | |
| Hose, | none | Gaskets, | none | Tools, | none | | | | | | | | | | | | | | | | |
| Repairs Boilers, | none | Arches, | none | Lines, | none | | | | | | | | | | | | | | | | |
| Water Glasses, | none | Gaskets, | none | | | | | | | | | | | | | | | | | | |
| Feed Water Heater, | none | | | | | | | | | | | | | | | | | | | | |
| Boiler Feed Pumps, | Packing .48 | | | | | | | | | | | | | | 4 | 8 | | | | | |
| Extras, | Set up Dearborn boiler compound Pump. Lines | | | | | | | | | | | | | 1 | 2 | 0 | | | | | |
| | " Pipe and Material | | | | | | | | | | | | | 2 | 5 | 9 | | | | | |
| | " Fittings. Bracket and Shelf "Shapley" | | | | | | | | | | | | | 2 | 0 | 0 | | 3 | 6 | 6 | 4 |

**ENGINES AND GENERATORS.**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Repairs Engines, | none | Repairs Generators, | none | | | | | | | | | | | | | | | | | | |
| Packing used, | none | Lamps Plant, | 1.44 | | | | | | | | | | | 1 | 4 | 4 | | | | | |
| Oils and Greases, | 7.61 | Switch Board, | none | | | | | | | | | | | 7 | 6 | 1 | | | | | |
| Cotton Waste, | 1.00 | Extras, | none | | | | | | | | | | | 1 | 0 | 0 | | | | | |
| Repair Traps, | none | | | | | | | | | | | | | | | | | | | | |
| Extras, | Sleeve and jack & draw No 3 gauge brushing "Shapley" | | | | | | | | | | | | | 1 | 8 | 4 | | | | | |
| | | | | | | | | | | | | | | | | | | 1 | 1 | 8 | 9 |

**HOUSE PUMPS AND LINES.**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Labor | 4 | Men $ | 2.25.00 | Less | 8½ | Hours Elevators $ | 3.30 | Plant. | | | | | | | | | 2 | 2 | 1 | 7 | 0 |
| Packing Steam, | Sump .23 | | | Water, | No 2 Elect. .10 | | | | | | | | | | 3 | 3 | | | | | |
| Valves, | none | | | | | | | | | | | | | | | | | | | 3 | 3 |
| Repairs Pumps, | none | | | | | | | | | | | | | | | | | | | | |
| " Motors, | none | | | | | | | | | | | | | | | | | | | | |
| Tanks and Lines, | none | | | | | | | | | | | | | | | | | | | | |
| Extras, | none | | | | | | | | | | | | | | | | | | | | |

**ELEVATORS AND ALL APPARATUS.**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Motors and Belts, | none | Cars, | none | | | | | | | | | | | | | | | | | | |
| Controlls and Lines, | none | " Fibres, | none | | | | | | | | | | | | | | | | | | |
| Extras, | none | " Cables, | none | | | | | | | | | | | | | | | | | | |
| | | Waste, Oils, Grease, Etc., | 2.98 | | | | | | | | | | | 2 | 0 | 8 | | | | | |
| Triplex Pumps, | none | Plunger Packings, | No 1 .180 | | | | | | | | | | | 1 | 8 | 0 | | | | | |
| " " Packings, | No 2 .80 | Leather Valves, | 1.84 | | | | | | | | | | | 2 | 6 | 4 | | | | | |
| " " Valves, | none | Tank Compound, | 15# @.16 | | | | | | | | | | | 2 | 4 | 0 | | | | | |
| " " Extras, | none | Extras, | Window top of shaft ✓.20 | | | | | | | | | | | | 2 | 0 | | | | | |
| | | | Signals 1/2 .50 | | | | | | | | | | | | 5 | 0 | | | | | |
| Compound Pump, | none | | | | | | | | | | | | | | | | | | | | |
| " " Packings, | none | Air Compressor, | none | | | | | | | | | | | | | | | | | | |
| " " Valves, | none | | | | | | | | | | | | | | | | | | | | |
| " " Extras, | Repair sight feed. new glass & gaskets .25 | | | | | | | | | | | | | | 2 | 5 | | | | 9 | 8 |
| Work Total, | 8½ Hours .40 | per Hour | 3.30 | | | | | | | | | | | | | | | | | 8 | 8 |

**GENERAL ACCOUNTS.**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scaps Hand, | .25 | Soap Common, | .30 | | | | | | | | | | | | 5 | 5 | | | | | |
| Tile Cleaner, | .35 | Laundry, | .30 | | | | | | | | | | | | 6 | 5 | | | | | |
| Mops, | .25 | Polishes, Etc., | .75 | | | | | | | | | | | 1 | 0 | 0 | | | | | |
| Paints and Brushes, | none | Printing, | none | | | | | | | | | | | | | | | | | | |
| General Supplies, | Exp. Lamps. samples .45 ✓ | | | | | | | | | | | | | | 4 | 5 | | | | | |
| Shop Tools, | Oil Stone .65 | | | | | | | | | | | | | | 6 | 5 | | | | | |
| Motors Plant, "all" | none | | | | | | | | | | | | | | | | | | | | |
| Fans " " | none | | | | | | | | | | | | | | | | | | | | |
| Extras, | Pails hot water bibb sink .05 | | | | | | | | | | | | | | | 0 | 5 | | | | |
| Windows rear Boilers broken by Balls war yard. .295 ✓ | | | | | | | | | | | | | | | 2 | 9 | 5 | | | | |
| One quire Corneling 40 yds. .09 .360 Credit up 17 yards out 9½ each | | | | | | | | | | | | | | | 3 | 6 | 0 | | | | |
| One piston from Quintle Pump 1.70 Lenient .50 | | | | | | | | | | | | | | | 2 | 2 | 0 | | | 1 | 1 |
| | | | | | | | | | | | | | | | | | | | | 6 | 9 |

0.53

Outside Work 63 Hours .40 per Hour - - - $ 25.20

Work 8½ Hours on Elevators .40 per Hour - 3.30

28.50

Elevator Supplies - 9.87

38.37

All Other Charges Foreign to Plant ✓Window .295 ✓Rear .295 Exp. Lamps .325 - - - Cr. not taken

Foreign Charges - $ 38.37

Maintenance

Current Generated 33630 K. W. Hrs for One Month Cost 1.90/100 per K. W. Hour and Maintain Entire Apparatus at $640.53

" " Less Foreign Charges ( 38.37 ) 1.78/100 per K. W. Hour

" " " " and $ 190.00/476.66 Cr. for heating Block, Bath, Hot water, Barber, Steam Pumps, Carnegie Library Etc. 1.36/100 per K. W. Hour

" " @ .04 per K. W Selling Price $ 1345.20 Total Expenses $ 640.53 PROFIT $ 704.67

Elevators Made 2665 Trips and Cost 36/100 per Trip for Current.

Library lighting charge only. @ $5.00 per Month. No heat — Checks ✓ Should be credits. or $3.20

Hyde.

FIG. 13.

POWER PLANT REPORT FOR MONTH OF October, 1910. No. 10

| Day | Hours Boiler No. 1 Fired. | " " " 2 " | Coal Consumed. | Lbs. Ashes. | % Ashes. | Gal. Water Pumped. | " " Evaporated | Lbs. Water to lbs. Coal | Temp. Feed Water. | Lbs. Heating Pressure. | Inches Vacuum. | Hours Engine No. 1 Run. | " " " 2 " | " " " 3 " | Total K. W. Generated. | " Power. | " Elevators. | Hours Comp. Pump Run. | Elec. No. 1 " | " " " 2 " | " Jack P. " | Elec. House No. 1 Run. | " " " 2 " | " Steam " Run | Vacuum No. 1 Run. | " " " 2 " | Sump P. " 1 " | " " " 2 " | Air Comp. " | Boiler Feed No. 1 Run. | " " " 2 " | Trips Elevator No. 1. | " " " 2 | Cylinder Oil Used | Engine " " | Lbs. Grease " | " Waste " | Boiler Comp. Used. | " Elev. " " | 2 C. P. Lamps " | 8 " " " | 16 " " " | 25 " " " | Spec. C. P. Lamps " | Arcs Trimmed. | Hrs. Repairs Plant. | Cost Supplies " | Hrs. Outside Work. | Supplies " " | Hrs. Repairs, Elevators. | Supplies " | Over Time Lighting. | Loads Ashes | Weather |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 24 | 0 | 3961 | 1006 | 13 3/10 | | 6344 | 8 2/10 | 210 | 1/2 | 2 | 6 | 1 1/2 | 17 | 1220 | 340 | | 0 | 11 | 18 | | 15 1/2 | 9 | 0 | 15 1/2 | 9 | 8 1/2 | 9 | 1 | 15 1/2 | 9 | 610 | 325 | | | | | 5 3/4 | 3 1/2 | 0 | | | | | | | | | | | | | | | 4 1/2 | 0 | | |
| Sunday H.-S 2 | 24 | 0 | 4280 | 743 | 17 3/10 | | 3553 | 5 3/10 | 208 | 1/2 | 2 | 18 1/2 | 7 | 0 | 510 | 60 | | 0 | 0 | 6 1/2 | | 0 | 24 | 0 | 0 | 24 | 0 | 24 | 0 | 21 | 3 | 0 | 74 | | | | | | 0 | 0 | | | | | | | | | | | | | | | | 0 | 0 | | |
| 3 | 24 | 0 | 7215 | 986 | 13 7/10 | | 5108 | 7 | 210 | 1/2 | 2 | 5 | 3 | 17 | 1130 | 440 | | 0 | 11 | 18 | | 0 | 24 | 0 | 0 | 24 | 0 | 24 | 2 1/2 | 12 | 12 | 460 | 322 | | | | | 5 3/4 | 0 | | | | | | | | | | | | | | | | 3 1/4 | " | | |
| 4 | 24 | 0 | 6863 | 970 | 14 2/10 | | 5800 | 8 3/10 | 210 | 1/2 | 2 | 5 | 3 | 17 | 1130 | 440 | | 0 | 11 | 18 | | 0 | 24 | 0 | 0 | 24 | 0 | 24 | 1 1/2 | 0 | 24 | 347 | 488 | | | | | 5 1/2 | 0 | | | | | | | | | | | | | | | | 3 1/4 | " | | |
| 5 | 24 | 0 | 7224 | 1089 | 14 3/10 | | 6300 | 8 3/10 | 210 | 1/2 | 2 | 5 | 3 | 17 | 1239 | 150 | | 0 | 11 | 18 | | 0 | 24 | 0 | 0 | 24 | 0 | 24 | 1 1/2 | 12 | 12 | 456 | 317 | | | | | 3 1/2 | 0 | | | | | | | | | | | | | | | | 4 1/2 | " | | |
| 6 | 24 | 6 | 7563 | 1145 | 15 1/10 | | 6524 | 8 2/10 | 210 | 1/2 | 2 | 6 | 1 1/2 | 17 | 1159 | 260 | | 1 | 11 | 18 | | 0 | 24 | 0 | 0 | 24 | 0 | 24 | 1 1/2 | 24 | 0 | 335 | 997 | | | | | 4 | 0 | | | | | | | | | | | | | | | | 3 1/2 | " | | |
| 7 | 24 | 0 | 7494 | 960 | 12 8/10 | 30106 | 4900 | 8 5/10 | 210 | 1/2 | 2 | 8 | 1 1/2 | 15 | 1210 | 280 | | 3 | 9 | 15 1/2 | | 0 | 24 | 0 | 0 | 24 | 0 | 24 | 1 | 24 | 0 | 503 | 328 | | | | | 3 1/2 | 0 | | | | | | | | | | | | | | | | 3 1/2 | " | | |
| 8 | 24 | 0 | 7015 | 941 | 13 4/10 | | 5700 | 8 1/10 | 210 | 1/2 | 2 | 6 | 1 1/2 | 17 | 1060 | 210 | | 0 | 11 | 18 | | 0 | 24 | 0 | 0 | 24 | 0 | 24 | 2 | 24 | 0 | 351 | 533 | | | | | 3 1/2 | 3 | | | | | | | | | | | | | | | | 4 3/4 | " | | |
| Sunday S. 9 | 24 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Sunday S. 9 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 30 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

FIG. 14.

cessful the reservoirs must be large enough to hold the excess water which the windmill pumps during high winds so that this excess water will be available to keep the waterwheel running when there is a calm and the windmill is "dead." This arrangement would be commercially successful if the cost of the windmill, pumping apparatus, reservoirs, piping, waterwheel and dynamo were not so great that the interest on the money spent, together with the operating cost and the upkeep charge, would exceed the interest on the investment in another system, such as steam or gas power, plus the cost of operation, upkeep, fuel and water.

To build a tower 1000 feet high sufficiently large and strong to support the quantity of water needed by a system of commercial size would involve such an expenditure that a plant for commercial use could not be built.

Another popular proposed system of obtaining power without using fuel as a source, is that of converting the heat energy radiated by the sum into electrical energy. In one system for doing this a

No 10 **Fuel and Evaporation** Oct-Nov-Dec 1910 **Switch Board Load.**

| Date. | Firemen. | Day. | Night. | Coal Each Man. | Total Both Men. | Average 12 Hours. | Average 24 Hours. | Average Month. | Total for Month. | Ashes Lbs. | Ash % | Water Evaporated Lbs. | Lbs. Water to Lbs. Coal. | Low Ampers. | High Ampers. | K. W. Weekly. | K. W. Monthly. | Cost Current Monthly. | K. W. Power Weekly. | K. W. Power Monthly. | Cost of Power Monthly. | K. W. Elevator Power Monthly. | Power for P'r'g Dep't, House Pumps, Fans, Etc. | Trips No. 1 Elevator. | Trips No. 2 Elevator. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | 1,136.68 Cons for all, 1909 | | | | | | | |
| Oct 1 | Garrick | ✓ | | 3725 | | 3835 | | | | | | | | | | | | | | 1700 K.W.H. @ 1.5¢ = $25.50 | | | | | |
| | Johnson | | ✓ | 3636 | 7361 | 3636 | 7361 | | | 1006 | 13 6/10 | 63666 | 8 7/10 | 65 | 875 | 1210 | | | 310 | | | | | 610 | 324 |
| " 9 | Johnson | ✓ | | 27485 | | 3785 | | | | | | | | | | | | | | | | 1215 K.W.H. @ 1.5¢ = $18.23 | | | |
| | Garrick | | ✓ | 20167 | 48662 | 2881 | 6666 | | | 6870 | 14 7/10 | 420833 | 8 5/10 | 45 | 700 | 8710 | | | 2120 | | | | 400 = 4.48 | 2487 | 2538 |
| " 16 | Johnson | ✓ | | 26055 | | 3722 | | | | | | | | | | | | | | | | | 300 = 3.36 | | |
| | Garrick | | ✓ | 19622 | 45727 | 2910 | 6632 | | | 5587 | 13 | 388933 | 8 3/10 | 45 | 760 | 7160 | | | 1550 | | | | Elevator | 2282 | 2312 |
| " 23 | Garrick | ✓ | | 27723 | | 3860 | | | | | | | | | | | | | | | | | | | |
| | Johnson | | ✓ | 19793 | 47466 | 2820 | 6780 | | | 6780 | 14 2/10 | 394250 | 8 3/10 | 45 | 800 | 7530 | | | 1850 | | | | | 2668 | 2601 |
| " 29 | Garrick | ✓ | | 29301 | | 3900 | | | | | | | | | | | | | | | | | | | |
| | Johnson | | ✓ | 20149 | 47450 | 2735 | 6635 | | | 7481 | 15 2/10 | 355250 | 8 3/10 | 45 | 1000 | 7620 | | | 1800 | | | | | 2977 | 2477 |
| " 31 | Hyde | ✓ | | 6184 | | 3087 | | | | | | | | | | | | | | | | | | | |
| | Garrick | | ✓ | 4515 | 6699 | 2257 | 5294 | | | 1625 | 21 3/10 | 54249 | 9 3/10 | 45 | 275 | 1400 | | | 180 | | | | | 810 | 387 |
| | | | | | | | | 26544 | 206355 | 25773 | 15 3/10 | 1745715 | 8 7/10 | 46 | 743 | 33630 | | | 7900 | | | | | 15434 | 10220 15774 26634 |

Fig. 15.

multitude of thermoelectric couples is used. The hot junctions of the couples are exposed to the heat of the sun and an electric current is generated. The current so made is used to change a storage battery. The number of couples used must be large enough not only to furnish current for the day load, but also to change the battery so that current can be drawn from it at night and on cloudy days when the couples are not generating, due to the fact that there is no heat from the sun available. As in the previous case, the cost of constructing a system of this kind more than offsets the gain due to the fact that there is no fuel or water expense involved.

Another means devised to utilize the sun's radiant energy consists of an air-tight glass chamber or boiler, in which water is heated by the sun rays and steam at atmospheric pressure is generated, and a low-pressure turbine outfit to utilize the steam so generated. The turbine may operate either an electric generator or, preferably, a pump for raising water to an elevated reservoir from which the water flows as needed to run a water-wheel and generator.

Recently, Prof. R. A. Fessenden, of Washington, D. C., in a paper presented to the engineering section of the British Association for the Advancement of Science, outlined a plan whereby power on a commercial scale may be obtained from the sun and wind. He proposed to combine wind- and sun-power apparatus in order that a plant might be capable of furnishing a fairly constant output with only moderate storage capacity. His paper aroused considerable interest, especially as he intimated that he has a 3000-horsepower plant under construction at a worked-out copper mine. By locating the plant at the mine it will not be necessary to provide any tower for the upper water-storage reservoir, for it will be built at the mouth of the shaft while the lower reservoir will be placed in one of the bottom chambers of the mine, 1000 feet below.

The two features of novelty in Professor Fessenden's scheme seem to be the combination of windmills with sun-radiation power apparatus and the subterranean reservoir. In his "sun-heat boiler" the water is to be directly exposed to the sun's rays under the double glass roof of a building which forms really the shell of the boiler. The steam or vapor is to be generated at, or near, atmospheric pressure and led off to a low-pressure steam turbine discharging into a condenser. Details of the design have not been given out, but it is stated that the water to be used will contain a small amount of potassium bichromate and flow in thin streams over the floor of the absorption room, the thickness of the streams being regulated to the amount of sun radiation being absorbed at any moment. The glass of the roof will be tinged green by a slight amount of iron sulphate so as to reflect back into the interior any radiation from the water itself, while still being fairly transparent to the sun's rays.

It is assumed that the low-pressure turbine will either pump water when the wind and commercial load are slight, or will furnish power direct when the wind and load are heavy.

One large windmill, or series of smaller windmills mounted upon a turn table, is proposed for utilizing the energy of the wind, particularly when the sun is not shining. These windmills are to be connected in some way by rope drives to a common shaft drive which will pass down the shaft of the mine and operate the pumps located at the lower reservoir to elevate the water to the surface reservoir, thereby storing the energy secured from the wind.

Without going into the details of the estimates submitted as to the cost of constructing the proposed plant, suffice it to say that, based on reasonable impartial figures, the cost of the plant will so much outweigh the cost of a steam plant of equal capacity that the scheme is shown to be wholly impracticable. The results obtained, however, will be interesting.

# Automatic Stokers Which Throw Coal

By F. R. Low

*This type of stoker is used extensively in Europe upon internally fired boilers. It spreads the fuel evenly over the fuel bed and will handle a variety of coals.*

In many European plants I found in use mechanical stokers which threw the coal more or less continuously over the surface of the fire. These were especially used upon furnace-tube and other internally fired boilers with constricted furnaces to which they are more adaptable than the traveling grate or the underfeed. They are used successfully with all kinds of hard and brown coals, and to some extent with small brown-coal briquets. Lignite is used by mixing with other combustibles of larger lump. They are exceptionally well adapted to the

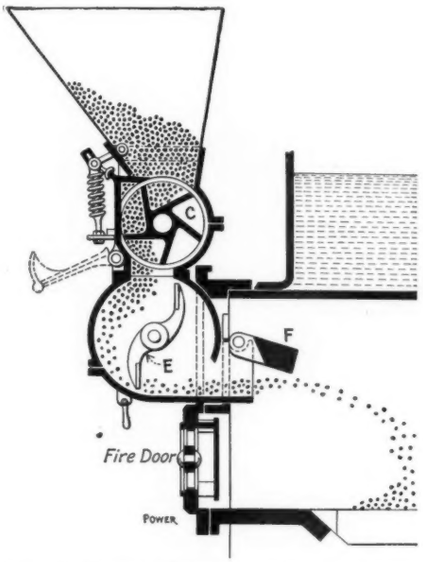



FIG. 1. LEACH STOKER AS MADE BY SAXON MACHINE WORKS

use of gassy coals on account of the thin fires which they carry and the rather free admission of air. In order to prevent too great an ingress of air through the hopper, it is recommended when stoking with briquets to mix them with a smaller coal to fill the interstices.

The wide range of variation in rate of feeding and the uniform distribution of the coal upon the grate, whatever the rate at which it is provided, adapt the stoker to varying demands, and several engineers whom I asked said that they had very little trouble with burning out the exposed parts. If the shovel and deflecting plates are eroded by impact with the coal they are easily and cheaply renewed. I did not meet with any case where what we would call large rates of combustion were being used with this type of stoker.

One important advantage of the type is that it may be used with any kind of a flat grate, and hence with a bar adapted to the fuel used, whatever that may be. The ordinary fire door is left intact and accessible so that the fire may be worked with the ordinary tools and in the ordinary way, or may be hand-stoked through the door in case of interruption to the operation of the stoker. For the long, narrow grates of internal-furnace boilers they are particularly adapted. They are used singly for such narrow furnaces or in batteries for the wider furnaces of externally fired boilers.

These stokers, although I found them largely in use on the Continent, are based upon English inventions, and naturally divide themselves into two types, one in which the fuel is brushed or projected into the furnace continuously, as in the type invented by Leach, and the other where the action is somewhat intermittent

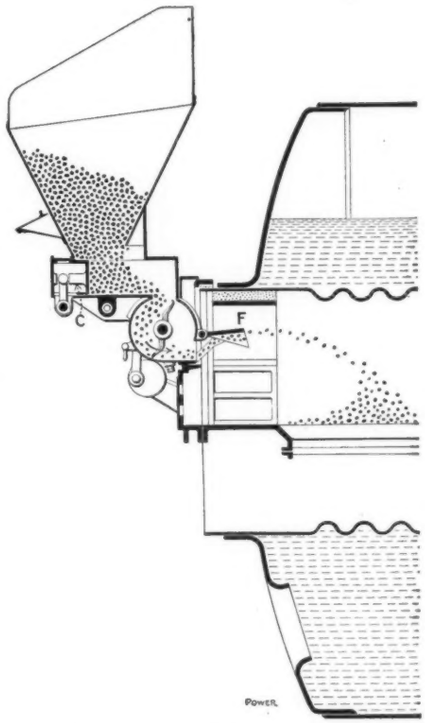



FIG. 2. LEACH STOKER AS MADE AT MERANE, GERMANY

as in that of Proctor. From a paper presented at a meeting of the International Association of Steam Boiler Inspection Societies at Lille, by Herr Oberingenieur Prössel, of Chemnitz, I am able to present several sections of the principal examples.

Fig. 1 shows the Leach stoker as it has been made by the Saxon Machine Works at Chemnitz for twenty years. At the outlet of the hopper is a feed roll *C*, operated by a ratchet movement which delivers the coal to a housing in which is a blade wheel *E* turning at a speed of 400 revolutions or higher, which throws the coal into the furnace. Between the wheel and the furnace is a hinged baffle plate *F* against which the coal strikes and which is automatically and continuously moved up and down, distributing the coal over the entire fire bed. The ratchet wheel which drives the feed roll has a sliding cover adjustable by hand over a greater or less number of its

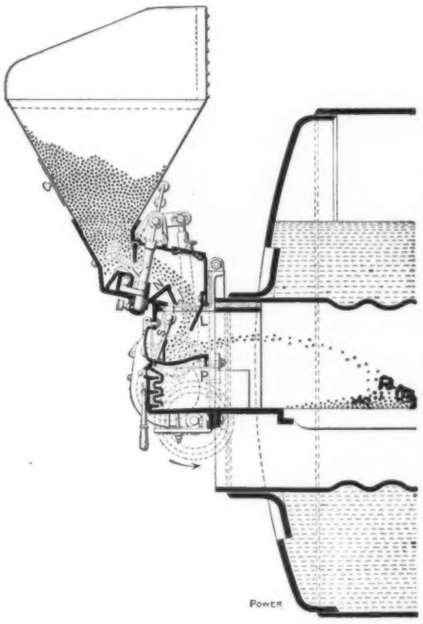



FIG. 3. THE PROCTOR STOKER

teeth so as to control the rate of feed with about ten gradations independent of those afforded by cone pulleys on the drive. This stoker is best adapted to sized coal; in particular, nut coals of from one-quarter to three-quarters of an inch in size. The use of briquets, except in the smallest sizes, is precluded, but the Leach apparatus, although thus restricted, and the more so because the price of its suitable fuel is relatively high, is much used, about 350 of them being under the care of the Saxon Steam Boiler Association.

In the Whittaker device, also an English invention, the feed roll *C* of Fig. 1 is replaced by a pair of crushing rolls which, being driven at a greater or less speed, control the rate of delivery of the fuel as well as reduce it to the proper size. The baffle plate *F* is adjusted by

hand. This furnace is quite popular in Austria.

Fig. 2 shows another modification of the Leach. It is made by F. L. Oschatz, of Merane, Germany, who replaces the rotary feed roll *C*, Fig. 1, with the reciprocating-piston arrangement *C*, Fig. 2. This is said to permit a larger size of coal to be handled, run-of-mine, lump and brown-coal briquets up to 2¾ inches being available. The baffle moves continually and the feed is regulated by the simple turning of a screw controlling the movement of the piston *C* from nothing to the maximum.

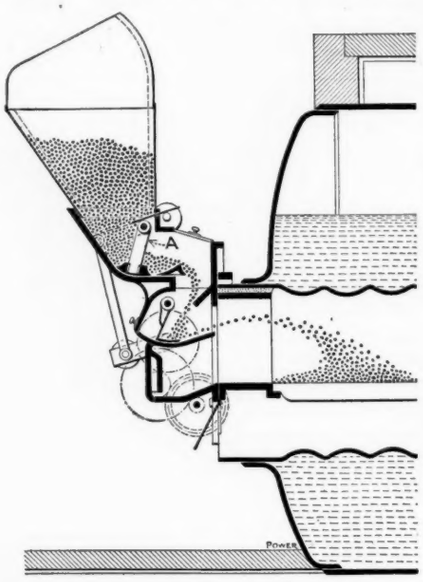



FIG. 4. STOKER MADE BY C. H. WECK

In the Proctor type the coal is periodically flung upon the grate by a pivoted plate, usually spring actuated. This plate, because it performs at least the projecting part of the work of that tool, is called the shovel. On one end of the shovel shaft is a toe engaging a cam wheel which has a number of protuberances, usually three or more, and is turned from the driving shaft. A lever on the other end of the shovel shaft is connected with one or two strong helical springs. When one of the protuberances of the cam comes in contact with the toe the shovel is thrust back away from the fire and the spring stretched. When the cam lets go, the spring throws the shovel toward the grate, hurling the coal, which has fallen before it, onto the fire. In consequence of the different hights of the protuberances upon the cam the shovel is drawn backward and the spring stretched to different degrees, throwing the coal successively onto different parts of the furnace and preserving a uniform fire bed. The rises upon the cams may be adjustable so that the stoker can be adapted to different grades of fuel, greater spring tension being needed for the larger sizes. They can throw sorted coal and run-of-mine up to 3¼ inches, in which they have an advantage over the type already described.

Illustrative of the Proctor type is the stoker built by Munckner & Co., of Bantzen, Germany, and shown in Fig. 3. The coal falls into the funnel in which there is a ring pusher, driven by the vertical shaft, which gives it a turning movement back and forth, pushing the coal forward in the direction of the boiler.

At each stroke of the pusher a determinate quantity of coal falls over the overflow nose *N* on the throw plate *P* in front of the shovel *S*, the guide *L* assisting in landing it within range of the stroke. The overflow nose *N* keeps the coal from dropping on the wrong side of the shovel.

In the stoker of C. H. Week, Dolau near Greiz, shown in Fig. 4, the coal is sent down to the shovel by a hinged pusher *A*. Passage is afforded for lumps of four or five and a half inches in size; the quantity fed may be adjusted by means of a handwheel during operation.

In the "Katapult" stoker, made by J. A. Topf & Sons, of Erfurt, and shown in Fig. 5, a relation is established between the movement of the feeding pusher and the shovel-operating cam whereby the amount of coal fed varies with the throw, being greatest for the longest throw and least for the shortest. This takes account of the fact that the combustion is most intense at the back part of the grate and also of the obvious certainty that some of the coal always falls short of its destination. The fuel is dropped in front of the shovel for its entire width instead of being allowed to fall in a heap.

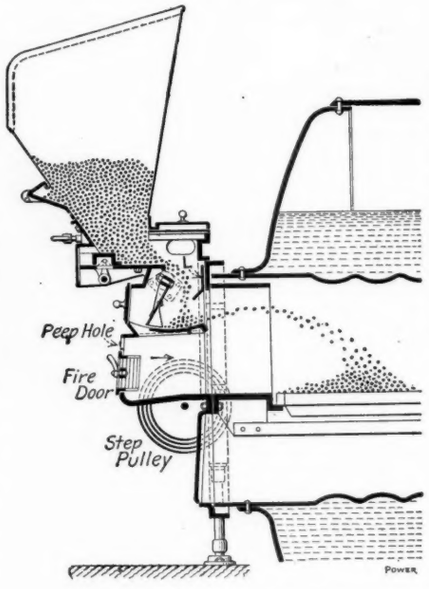



FIG. 5. "KALAPULT" STOKER

The deflecting plate *L* is made adjustable. Coal up to fist size, as well as briquets, can be used.

The trouble seems to be not so much with handling large sizes within reason as from the tendency of the finer stuff to pack, especially if it is wet. In the "M. A. N." stoker, Fig. 6, made by the Augsburg-Nürnberg Machine Company, an agitator *A* is provided just above the throat of the hopper and a poke hole *B* in the front of the funnel. A gate *C*, adjustable for fuel of different sizes, is placed where it will restrain the falling coal and place it more directly under the control of the pusher.

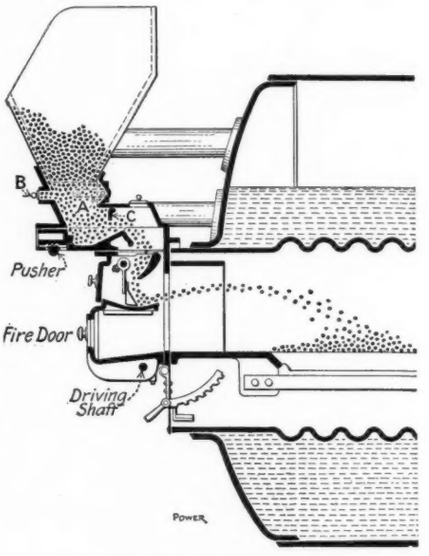



FIG. 6. "M. A. N." STOKER

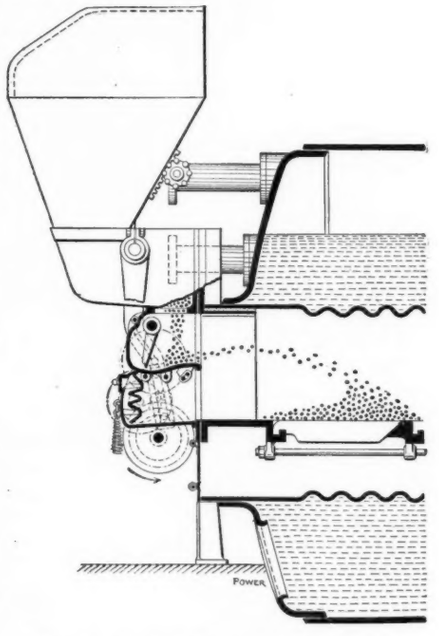



FIG. 7. STOKER MADE BY RUF & CO.

The Seyboth stoker, made at the Zwickauer foundry of Emil Selbmann, Zwickau, embodies a feed roll with many cavities whose dividing walls have edges which break up the large lumps. By this means irregular mixtures of coal or briquets can be used. It is pointed out

that one advantage of equalizing the size arises from the fact that large lumps are thrown farther than smaller ones and require a more forcible impetus. The mode of varying the throw of the shovel is somewhat different from that employed in the machines already described. Instead of having a series of projections or rises, the cam is an eccentric disk, each revolution of which corresponds to one throw of the shovel. By a gradually changing lever movement the same is brought into contact with the tension toe on the shovel shaft earlier or later, thus putting the springs through a long cycle of variations in tension and apportioning the distance to which the coal is thrown upon the grate by a series of small gradations. A stoker of this type is also built by the Esslingen Machine Works in Esslingen; and the "Cyclop," made by Mehlis & Behrens at the Cyclop Machine Works at Berlin, contains also the rotary-crusher feature. The biparted throw plate is also used in the stoker made by the Dingler Machine Company, of Zweibrüchen.

The stoker of Ruf & Co., Bautzen, Saxony, Fig. 7, differs from the others in having the throw plate beneath the shovel made in two parts, the front one of which is hinged and by its inclination determines, in connection with the varying force of the shovel push, the distribution of the coal. It may be easily adjusted while the furnace is in operation. The varying impetus is obtained with the usual cam and toe arrangement. The pusher is of a form designed to prevent clogging and is almost entirely relieved of the pressure of the coal in the hopper; lumps four inches and more can be handled.

There may be mentioned another type of throw stoker which has lately appeared in which the shovel is not pivoted above but beneath the stoking plate, of which the shovel forms to a certain extent a part. This system is used in the Stelzner stoker, made by the Kaiserslautern Iron Works in Kaiserslautern, Pralz.

Less than one-half a horsepower is required to operate any of these stokers when crushing rolls are not included.

In our own country this type of furnace is of comparatively recent introduction. A description of that made by the Erie Foundry Company appeared on page 700 in our issue of April 13, 1909, and of the Vulcan, made by the Vulcan Furnace Company, in our issue of January 11, 1910. A still later type, made by the Parsons Manufacturing Company, of New York, in which the fuel is injected intermittently by air blast, is described on page 2048, November 15, 1910.

# Control of Indirect Heating System

By H. R. Rogers

*Leakage through the walls and doors of the plenum chamber produced too high a temperature in the mixing chamber and made it almost impossible to maintain the desired temperature.*

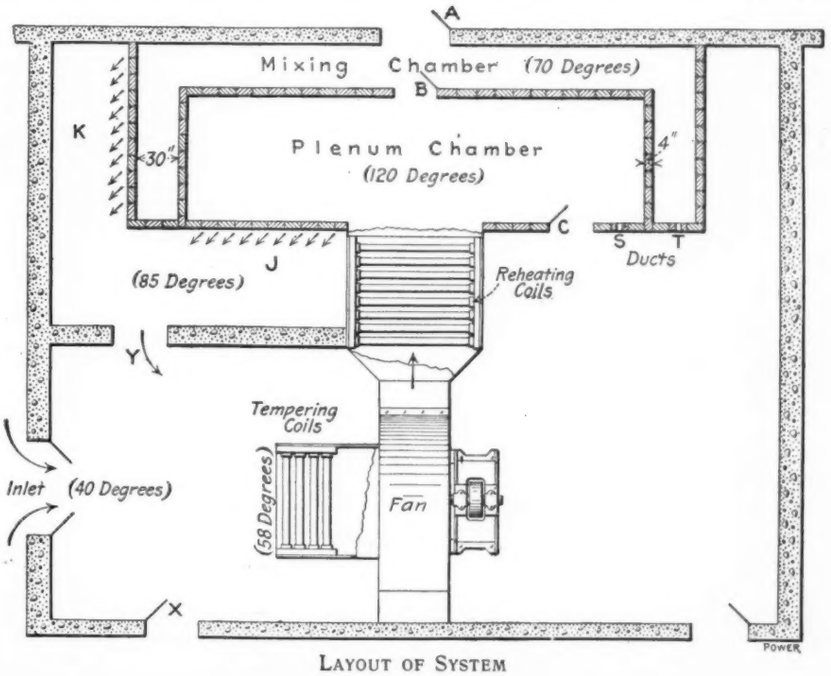
The cubical content of a certain building was about 800,000 cubic feet, and the capacity of the fan was about 40,000 cubic feet per minute; this gave a change of air every twenty minutes. The average outside temperature was 40 degrees and the temperature maintained inside was 68 to 70 degrees. The accompanying sketch shows the plan of the plenum chamber, the mixing chamber and the fan inlet; also the temperatures are indicated as observed after it was discovered that the system was not fulfilling the requirements.

The plenum chamber was about 14x 32x12 feet, with four brick walls and a concrete floor. The mixing chamber was 30 inches wide, surrounding three sides of the plenum chamber and having an outer door at *A* through which to enter the mixing chamber, and an inner door at *B* to enter the plenum chamber. As the latter door was found to leak badly, it was taken out and the aperture was bricked up and the same door installed at *C*, where the leak could not affect the tempered air.

The tempered air passed under the plenum chamber (directly under *H*), to reach the mixing chamber. But it was found that the floor of the plenum chamber at *H* had not been completed up to the edge of the reheating coils, and there existed a crack about three inches wide and nine feet long. This proved to be one cause for the temperature being too high in the mixing chamber. At the place indicated by the small arrows *J*, it was found that the 4-inch brick wall leaked at almost every joint, the current of air coming from any of these leaks being strong enough to extinguish a lighted match, and the pressure in the plenum chamber was barely ⅜ inch.

The temperature carried in the plenum chamber was at times as high as 120 degrees Fahrenheit, and the outside temperature was usually 40 degrees. It was impossible to keep the proper temperature in some of the rooms, especially those that had 12-foot ceilings. The temperature in these rooms would reach as high as 80 degrees, as they were situated only about 50 feet distant and were receiving the air direct from the plenum and mixing chambers, and the velocity of the air into them was approximately 325 feet per minute. The dampers in the plenum and mixing chambers were controlled by an apparatus for regulating the temperatures, but as this was found to be in perfect working order, the lack of control could not be laid to it.

It may be noted from the sketch that air would be drawn through the door *Y*, which was proved by hanging a thermometer directly in front of the temper-




LAYOUT OF SYSTEM

ing coils, when it was found that the temperatures ran as high as 58 degrees, with an outside temperature of 40 degrees. The air would go through the fan and either under or through the reheating coils, and the reheated air that did not go through the hole in the floor at this point went into the plenum chamber. Enough air, however, passed through the hole to raise the temperature in the mixing chamber to 70 degrees, even after the steam was shut off from the tempering coils.

With the air coming in at 70 degrees, the heat from the occupants and from the lamps raised the temperature to 80 degrees at times, about 12 degrees too high to be comfortable.

To remedy the matter a door was placed at *Y* and kept closed, after which there was no perceptible leak through *J* and *K*. Before this door was hung and kept closed, the pressure in the plenum chamber and the suction of the fan would cause all the air that came through the leaks to be reheated and recirculated.

The hole in the floor was stopped up in a permanent manner and ports were made into the plenum and mixing chambers, as shown at *S* and *T*, and thermometers were placed there. It was then found that 120 degrees could be maintained in the plenum chamber and 55 degrees in the mixing chamber when the outside temperature was 45 degrees, and there was no trouble in controlling the temperatures in the rooms where there had previously been difficulty.

If those who are experiencing trouble in maintaining temperatures would hang thermometers in various places, they might learn a great deal. I consider it just as essential to have a thermometer in the plenum and the mixing chambers as it is to have a pressure gage on a boiler, for without these it is impossible to be sure of just what is going on, especially when some ventilation is required and very little heat is needed.

It is bad practice to build plenum chambers with 4-inch walls unless they are plastered on both sides with a coat of cement, as the difficulties mentioned are apt to occur, and without the thermometers no one would be the wiser.

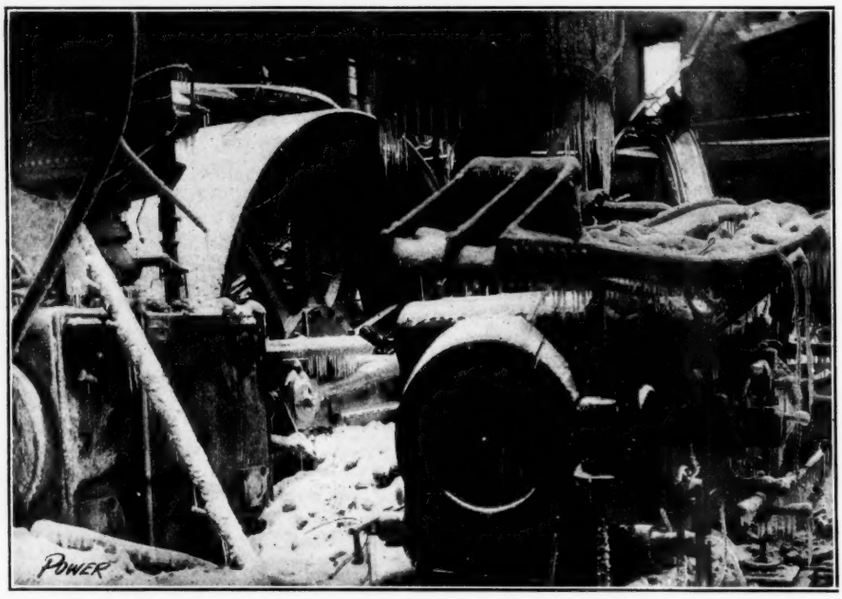



FIG. 1. ONE OF THE CORLISS ENGINE UNITS

FIG. 2. REMAINS OF THE BUILDING

## Minneapolis Power House Burns

About 6:45 a.m., Friday, January 6, fire broke out in the engine room of the Main street station of the Minneapolis General Electric Company and rapidly reduced the generating side of the station to a mass of scrap. The fire, as near as can be ascertained, originated in the northeast corner of the building near the incoming feeders from the other stations which operated in parallel with this plant, and was the probable result of a short-circuit of some of the electric wires at this point.

In escaping from the fire two men were injured, one of them seriously but not fatally. The floor and roof of the building furnished most of the inflammable material and this, falling on the machinery, had the effect of concentrating the heat. Massive engine frames were in many cases cracked like glass, and it is estimated that the machinery is practically a total loss.

The plant contained one 1000-kilowatt direct-connected unit, two 1200-horsepower and one 700-horsepower belted Corliss machines, and a 1500-kilowatt Curtis turbo-generator. It operated also two waterwheels of approximately 2000 horsepower capacity, and contained one 1000-kilowatt motor-generator, which formed a connecting link between this station and the others in the system.

Notwithstanding the complete destruction of the engine-room side of the house, the boiler plant, containing ten 350-horsepower Stirling boilers, was not injured. A substantial fire wall separated the two parts of the building and it was due to this fact that the boiler room escaped.

Some extremely good work was done by the Minneapolis General Electric Company in making temporary connections whereby normal conditions in the lighting service were resumed. The city was without lights on the night of Friday, but, the following night, lights were burning as usual except in the case of about 1000 open arcs which had been supplied from the Main street station, using old-type Brush dynamos. These will be out of service until they can be replaced by magnetite arcs.

# An Industrial Plant Boiler House

By Warren H. Miller

*The details of design of boiler house and water-softening plant. Fire-tube boilers were selected because of low steam pressure and the hardness of the water. Simple coal- and ash-handling arrangements. Concrete blowoff sump.*

While this boiler house was primarily designed for the sole purpose of making and distributing steam, it has many features of interest and value to those engaged in the design of combined boiler and power houses for industrial plants. About larger manufacturing establishments, comprising big acreage and many buildings, the conditions are considerably different from those of the big city power houses, where ground space is limited and where the ash must be shipped away in gondola cars. For the latter type of plant some sort of conveyer for coal, and elevator for ash are the standard details, but for an industrial-plant boiler house, both can be replaced by simpler and cheaper devices. Probably the most economical way in which to serve coal to the boilers is to haul it in the cars up a trestle of about 5 per cent. grade and dump it into a bin which permits it to flow out in front of the boilers by natural slope, which, for buckwheat, is 33 degrees. Similarly, the easiest way in which to dispose of the ash is to collect it in cars in an ash trench in front of the boilers and haul the string once a day, dumping the ash on low or swampy ground about the works. Such a trench can be made very cheaply of concrete with manholes at each boiler, and steel dump cars can be gotten just about long enough to space one in front of each boiler. Following out these ideas, the boiler house, a cross-section of which is shown in Fig. 1, was designed. It will accommodate either fire- or water-tube boilers of 250-horsepower size. While the water-tube is shorter by nearly three feet, it needs this amount of extra room in the back alley because of the rear caps, etc.

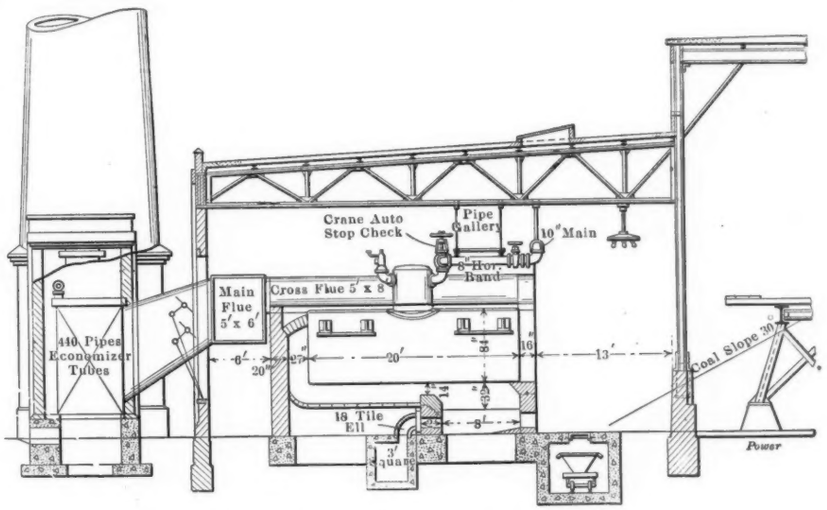



FIG. 1. CROSS-SECTION OF HALF OF BOILER HOUSE

## COAL TRESTLE

The trestle is a structural-iron affair with 24-inch I-beam stringers. It was adopted after much argument because of uniformity with other trestles about the works, but there is no question but that a concrete trestle would be cheaper and more durable. It has often been the experience in using iron bents in coal bins that they rust quickly from the sulphates in the coal unless dug out and repainted at least once a year. The all-steel trestle costs about $10 a running foot and the concrete-pier trestle, with steel I-beam stringers, costs a little over $8 per foot. The hight of the top of the rail on the trestle should not be over 13 feet; the distance from the center line of the trestle to the face of the wall should be 11 feet. The bin walls were made by raising the foundation piers 7 feet above grade and making a retaining wall of them. Each pier was 5 feet wide with an intermediate wall 4 feet wide carrying no column. This arrangement left two doors in each bent 3 feet 6 inches wide. A 3-inch channel was cast vertically in the face of each concrete pier, thus giving a slide for the doors, so that the amount of the coal slope can be adjusted at will. The pressure of coal is very considerable, and it becomes a live load whenever a car is dumped; the descending coal produces a great shock. It is capable of bulging an ordinary 8-inch brick wall if dumped against it to any hight, or bending 4x12-inch yellow-pine bin boards, if the span is over 8 feet between posts.

The floor of the bin is of concrete, smooth finished and pitched each way to a gutter running along the boiler fronts, which also catches the hose water from wetting down ashes. Another scheme for draining the coal bin is to build a blind drain of brickbats laid in a trench running down the center of the bin. This drain is covered by the floor, except for a square opening in the center of each bent. This opening just holds four bricks laid loose. Such a drain will dispose of all rain water which may get into the coal, and will never have to be dug up like a tile drain when laid under concrete.

## ASH HANDLING

The ash trench is 6 feet by 5 feet 2 inches in cross-section, with a 7-inch reinforced-concrete roof and 9-inch plain walls, made by setting up interior forms and pouring concrete between them and the sheer walls of the excavation. The roof was poured before the wall forms were struck, in order to avoid the liability of the earth pressure bulging the walls in. The 30-pound rails of the 36-inch industrial track are laid on sills in the cement. The dump cars used were manufactured by Wonham & Magor; each is of 2 cubic yards capacity and cost about $80. Using a 2-foot spacing link, their length is such as to place one of them in front of each boiler, with a spare in each of the two alleys. Each car stands directly under a cast-iron 24-inch street manhole, cast in the concrete roof of the ash trench. After the fires have been cleaned, the heap of hot ashes and clinkers is wet down with the hose, the manhole cover lifted with a slice bar and the ashes hoed into the cars below. Each car will hold three cleanings and constitutes both ash bin and conveyer and is far cheaper than either, for 16 cars, serving as many boilers, cost only $1280. They are hauled at 7 o'clock, morning and evening, by the work's electric storage-battery locomotive. The approaches to the ash trench are down 5 per cent. grades from the street level, one straight and the other curved on a radius of about 60 feet. A six-ton locomotive can haul five cars up such a grade, and a ten-ton can take 8 to 12 of them up.

## BOILERS

The boilers were chosen fire-tube because of the low steam pressure, 80 to 100 pounds, and because of the hardness of the feed-water supply which contains over 18 grains of solids to the United States gallon. There was no hope of softening this below four grains even

with the best water-softening equipment that could be devised, because the water was one of the "impossible" variety, such that by the time enough lime and soda have been put in to make all the impurities soluble, there is so much in that the boilers foam to a degree beyond all safety for the engines. While evaporation, capacity and economy of upkeep are, in the long run, about equal with fire- and water-tube boilers of first-class make, the cleaning account of the former is undoubtedly much smaller, being only a three days' job for three men in a 250-horsepower boiler, whereas the water-tube of the same size takes five men a little more than a week. It is the writer's belief that the water boiled is the most important consideration of all. About 90 per cent. of all the accidents and repairs about boiler plants are primarily due to the water and its quality, and yet it is often the last thing considered. The boilers cost about $26,000 for sixteen, against $41,000 for an equal number and grade of water-tube. They are 84 inches in diameter and 20 feet long; the shell is 7/16 inch thick; the joints are triple-riveted butt-strap. The main steam outlet is 8 inches in diameter; the feed, 2 inches; the surface blow, 2 inches; the bottom blow, 3 inches, and the equalizer 2 inches. Each boiler has two 4-inch pop safety valves. The boilers are set in batteries of four so as to have one 5x3-foot cross-connection flue to each pair of boilers. Since, if one boiler were let down and opened, the draft of the other boiler would be broken, dampers were put in by running a dividing plate from the front wall a short distance down the flue, thus parting it in halves; in the passages thus formed the dampers were swung.

### Flues and Economizers

The main flue is 5x6 feet in section throughout. It was possible to keep to this size by placing the chimneys in the center of each side of the boiler house, with the economizers on each side of the chimneys. The arrangement of the boiler house is eight boilers on a side, with foundations for four futures. The flue is built for the entire twelve with a dead damper beyond the eighth boiler which can be closed while the future boilers are being connected in. As two boilers are directly opposite the economizer entrance, no section of the main flue is used by more than four boilers at once, whether direct into the chimney or indirectly through the economizer.

The economizers are for six boilers each, but, at present, four feed through one economizer and four down the flue into the other. The location of the four economizers on opposite sides of the chimneys and entirely outside of the boiler house is an arrangement often used by the writer because of the numerous advantages it affords. It costs little if any more than the arrangement of locating the economizer above the main flue, or of backing it up against the back wall of the boiler house, and it gives not only free access to the economizer on all sides, but also plenty of light and air in the alley behind the boilers.

It would seem that few outside of the firemen on the job really appreciate how valuable light and ventilation actually are. Here are located all of the blowoff valves and cocks, surface blowoffs, equalizers, back-cleanout doors and flue-cleanout doors, and, if the boilers are water-tube, here also are all of the thousands of tube caps, which must be cleaned, replaced and tested. If this alley is a dark tunnel and a sweatbox, as is the case if the rear wall is left blank and the economizers backed up against it, these things will be looked after and repaired by the light of a few lanterns or kerosene torches, and will be one of the "meanest" jobs about the boiler house. But, with the economizers outside, there are light and air in the tunnel; there is room about the economizer itself to take out a cracked header or a defective tube, and there are air and light overhead to handle the scraping mechanism and to clean the blessed thing whenever it needs it, which is about every six months at least, and the job takes about two weeks of steady work. As to difference in cost, wide and massive foundations for boiler-house wall, requiring special concrete forms, are avoided; the solid brick wall of the boiler house, which would have to be faced with firebrick, is replaced with window frames and a 12-inch panel wall which is cheaper, and, in addition, one side of the economizer may be covered with the sectional coverings which come with the economizer, so the difference in cost will not be very great—far less than the real advantages that it gives in the work of making steam.

### Chimneys

The chimneys, 9 feet in diameter and 125 feet high, are built of radial brick; have common-brick bases which extend up as far as the economizer tops, and are lined with firebrick for 30 feet from the bottom. The flues enter each side, and the direct bypass from the main flue to the chimney enters the brick neck, joining the chimney with the economizer houses on each side of the chimney. Competitive bids were received on reinforced-concrete and radial-brick chimneys. The latter type was chosen in spite of the lower cost of the former. The appearance of the concrete stack is hardly in its favor, as it is impossible to avoid the effect of separate rings caused by each successive batch of concrete, and these rings spoil the unity and column-like appearance which is the chief beauty of a chimney. The durability of the concrete chimney is also probably less than that of the radial-brick, but this remains yet to be proved, as the oldest concrete chimney in America, to the writer's best knowledge, is not over ten years, and is lined from top to bottom with firebrick, making it more expensive than a radial-brick chimney. While a number of poorly built concrete chimneys have had to be taken down, there should be no hesitation in using them at the present time, if price is the first consideration. The radial-brick chimneys for this plant cost about $2700 each. The economizers cost $13,000, erected, for four containing 440 nine-foot pipes each. Their capacity is 1250 horsepower with feed water at 180 degrees and flue gases at 410 degrees. The foundations, setting and houses, made by carrying up the walls above the economizer tops and putting on a roof, cost under $5000 for the four, including the electric drive.

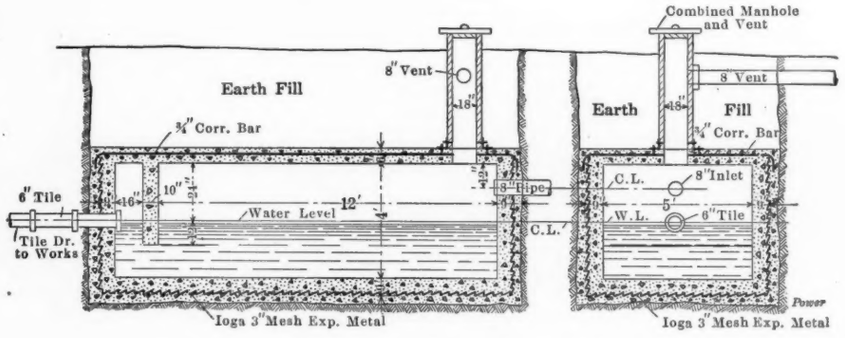



FIG. 2. DETAILS OF REINFORCED-CONCRETE BLOWOFF SUMP

### Grates

The coal burned is buckwheat anthracite, containing much slate, costing about $1.10 a ton and containing 20 per cent. ash. To burn it a pinhole grate and fan blast are required. Two three-quarter-housing, bottom-discharge, Sturetvant 8x12-foot fans supply the blast through reinforced-concrete air ducts, with openings in the bridgewall into the ashpit, controlled by cast-iron swing blast doors. One of the fans is driven by a Sturtevant 10x12-inch heavy-duty fan engine, running at 150 revolutions per minute and the other by a 40-horsepower induction motor. Either fan will furnish the blast for all of the boilers, so as both steam

and electric drive are available, it is almost impossible for the fan equipment to be shut down.

### Auxiliaries

The fans, engine, motor and three large 15 and 10½ by 18-inch, duplex, boiler-feed pumps are all located in one house under the care of a water tender, who also looks after the water-softening plant adjacent. The arrangement is very simple and compact, and is made possible by simply putting in a relief valve from the boiler-feed discharge main into the suction main. Each fireman tends water for his own boiler by his stop checks, and the feed pumps are run just a little above the intake of all the boilers that may be on. They use about 300 gallons per minute. Any excess that they do not use is discharged back into the suction through the relief valve.

### Water-softening Plant

The water-softening plant, like many properties of this company, is characterized by the utmost simplicity. If you reduce water softening to its simplest terms, you need two tanks for combined treating, agitating and settlement, two filters to remove any solid particles not settled out, and a pump to move the water. In this plant, treating 300 gallons of water per minute continuously, there are two iron tanks 20 feet in diameter by 30 feet high, with a 10-inch electrically driven centrifugal pump with a 40-horsepower motor, situated between the two tanks. This pump fills them alternately, taking 20 minutes to do it, adds the softening compound with a single turn of the motor, agitates by sucking from the top of the water level and delivering into the bottom for one hour. The tank then settles for three hours and is ready for use. A 6-inch connection, 2 feet above the bottom, is opened into one of the filters into which the water enters by a pocket in the side, and overflows at the top. The water then passes down through alternate 12-inch layers of sand and excelsior to a hole plate a foot above the bottom of the filter, which is 6 feet deep by 12 feet in diameter. From here the boiler-feed pump sucks the filtered and softened water for steaming purposes. As there are two tanks and two filters, the water in one is always being used while that in the other is being treated and settled. Seven tankfuls per a 24-hour day is the total available output. It is the simplest possible water-softening apparatus. An extra 20x30-foot tank was added later to provide extra settling and storage capacity. This tank is also used as a reservoir for preliminarly heating the feed water to 100 degrees by passing it through the gas-engine water jackets in the power house. The water itself is of villainous quality, containing 18 grains of solids per a United States gallon, and requiring the unusual proportions of 120 pounds of soda and 70 pounds of lime per tank. Only treated water can be used in the gas-engine water jackets or otherwise they would immediately scale up.

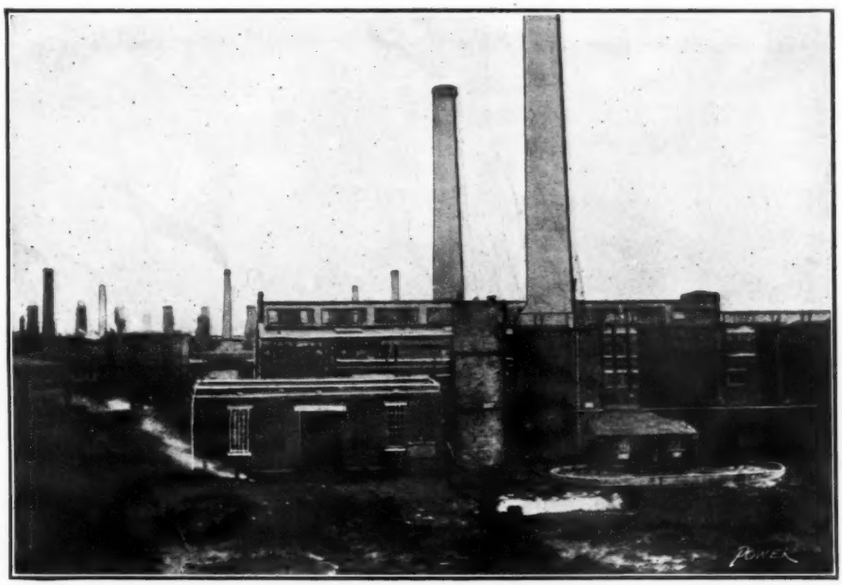


Fig. 3. General View of Boiler House, Fan House and Water-softening Plant

### Steam Distribution

The problem of distributing the steam to the various departments is solved by the usual "ring," crossing over the boiler house at each end by four 10-inch extra-heavy bends. A division gate valve, with Crane drip pockets duly trapped, is set at each four boilers, with a 10-inch outlet rising from a tee at each division valve. These lead out to the three main process departments, and to the power house (for steam spares, exciter and air compressors). The connections from the boiler domes to the steam mains consist of 8-inch extra-heavy pipe bends set horizontally and plain 8-inch angle valves coming into the main from the under side—a good flexible arrangement, and one that is self-draining for anything but wet, foaming steam. In the pipe gallery is also run the 6-inch feed-water ring with its direct connections from feed pumps and bypasses through the economizers. Out of the power section is also taken the 6-inch connection for the boiler-house auxiliary plant and the 6-inch connection for the mechanical shops. The 6-inch connection to the auxiliaries is set in a corner of the ring between a big department section and the power section, and protected by a special division valve, so that, in case of trouble with the power section, it can be carried by the departmental section.

### Blowoff System

The blowoff system consists of a 2-inch surface blowoff and a 1½-inch equalizer pipe for each boiler, together with a 3-inch bottom blow. The latter are of the Hancock type, which have the very commendable feature of a protruding pilot on the valve disk, which pilot fits inside the seat ring so closely as to push back any pipe scale or hard scale that may be coming through just as the valve is closing. The steam of the blowoff can still get past the pilot and scour the seat clean before the disk comes down on it, a long-felt want, as more blowoff-valve seats are ruined by small particles of scale getting under the disk just as it closes than by any other cause. In addition to this a 3-inch iron, straight-way asbestos-packed cock is put on the blowoff ahead of the valve. It is always open except just before opening the valve, when it is closed, the valve opened and then the cock. The reverse order is followed in closing the blowoff.

A screw ell is put on between the cock and the valve to give it swing, and, as the valve is of the angle type, flanged, it can thus be easily removed for repairs without disturbing the main. The latter is of 6-inch extra-heavy pipe with extra-heavy fittings, the whole main being kept above the concrete floor of the rear alley so as to be easily reached in case of clogging or other trouble. The meanest job in existence is digging up a leaky blowoff main full of hot steam and hard feeling, and in this plant it was kept entirely above board. The blowoff main leads by an 8x6-inch bull-head tee and connection under the economizer to a concrete blowoff sump, often used by the writer in industrial plants.

As this muddy and scaly blowoff water is at 350 degrees, nearly a third of it flashes into steam to restore the thermal equilibrium the instant it passes the blowoff cock and its temperature falls to a little above atmospheric, or 212 degrees. The volume of steam thus released amounts to about 1500 cubic feet in blowing down a single gage, and as this is a whole lot of steam, it will not do to turn

it into the tile drain system of the works, down a sewer, up a downspout or any other place where it is sure to do harm. The heat of this blowoff water is also so great as to crack drain tile for 60 to 100 feet of its length, and this in time would cave in because of the weight of the earth above and clog up. Therefore, if there is a number of boilers to blow down, and there is no empty swamp or ditch to blow into, a large sump is a necessity. It should be always half full of cold water so as to cool down the incoming blow by mixture, and it should have a vent for the escape of the blowoff steam and a trap to prevent any of the steam from getting into the tile drain system of the works. Such a sump, of reinforced concrete, costing from $200 to $300, is shown in Fig. 2. It is absolutely effectual in performing the functions outlined above and has been used a great deal in various boiler-plant installations by the writer. The steam vent should not be less than 8 inches for 250-horsepower boilers, blown one at a time, as, at that, the pressure developed in the sump is three or four pounds per square inch. If the sump is buried near the economizers, the best lead for the vent is up into the neck between the economizers and the chimney, so that the waste steam goes up the chimney.

### Structural Features

The roof truss, of the Warren girder type, is rather light for hanging heavy piping subject to waterhammer shocks, heavy pipe galleries, etc. The writer would have preferred the Pratt-Howe truss, with diagonals in tension all the way across, and reversed at the gusset taking the pipe hangers, but accepted the truss shown in deference to the fetish for "standardization" which possessed the works management. The roof construction is also standard for this works, consisting of I-beam purlins spaced about 5 feet, so that notched 2x4-inch hemlock joists could be laid in between the purlins and give support for a flat board centering. The reinforcement of ½-inch rods is laid both ways across the upper flanges of the I-beam purlins. Then the concrete roof is poured 4 inches deep and finished with an asphalt and gravel roofing. In two weeks the centering can be struck by simply knocking the joists out from the lower flanges of the I-beam. All of it can be used over again.

The hight of the bottom of the roof I-beams of the coal-bin monitor should be 22 feet above the top of track rails on the coal trestle. This hight is needed, especially in smaller plants, for the way train in collecting empties often backs a box car up the trestle. As the runway of this car will be 13 feet 6 inches, all of 7 feet is needed above for clearance. The total hight will thus be 35 feet from the floor. As the roof trusses over the boilers need not be over 22 feet from floor to bottom of truss chords, and the trusses will be about 5 feet 6 inches deep, there will be 7 feet of monitor window space available, lighting both bin and firing alleys, and also obviating the necessity of skylights. These latter are always more or less of a nuisance, but the broad band of vertical sashes along the monitor will give ample light and need never leak down on the firemen below. If every third sash is replaced with a louver, as was done in this house, good ventilation is obtained for locomotive smoke, ash, dust, etc. The walls are of red brick, laid up with red mortar, with 24x16-inch pilasters and panels of 12-inch red brick. The window sills, lintels, water table and copings are of reinforced concrete, smooth finished, and the economizer* houses and fan house were worked up in the same architectural construction.

### Electrical Lighting

The lighting takes 60 amperes with metallic-filament lamps. There is a row of Harter slag-glass four-light clusters with enameled-steel shades, ½-inch conduit stems, 3-inch black iron canopies and sheet-iron outlet boxes with canopy covers. The clusters hang in the center of the firing alleys from the bottom chord of each roof truss. They are connected by ¾-inch galvaduct conduit, running along on forged hook clamps on the bottom flanges of the purlins just above, and a ¾-inch conduler tee gives outlet at each truss. Each alley has two circuits each way from the center, alternate clusters being in each circuit. The whole is controlled by a two-wire, eight-circuit ironclad switch and cut-out box. There is also a separate circuit of four lamps in each rear alley, so that this subway will not be in Stygian darkness all night, and also to give connections for portables when cleaning out and scaling boilers. Along the pipe gallery runs a third circuit with a lamp at each water column, lighting water gage, steam gage and try cocks. All of these lamps were originally tungsten filament, taking a total of 30 amperes, but they all perished in a short time, in spite of their stable position, and were replaced by the more durable metallic filaments.

*See POWER, July 27, 1909.

## Junk Shuts Down Large Pumping Engine

By R. C. Turner

The half bushel of iron borings, rods, nails and other junk shown in the accompanying photograph were found riding on top of the piston in the low-pressure cylinder of the large triple-compound vertical pumping engine installed in the water works at Atlanta, Ga. The cylinders are 36, 64 and 90 inches in diameter, and when running condensing the pump has a capacity of 20,000,000 gallons in 24 hours.

Fifty-nine Pounds of Junk Taken from Low-pressure Cylinder

The machine has been in commission about six months but has been in operation only about half of the time. On December 1, the head on the intermediate cylinder cracked in three places and had to be replaced by the manufacturers. After this repair was made, the pump operated for about ten days when valve trouble developed on the low-pressure cylinder. The steam valves are of the poppet type and are located in the heads. After opening up this cylinder one of the valves was found to be stuck and the stem badly bent.

It is supposed that the ports in the head of the intermediate cylinder had not been blown out properly when the casting was made, and that most of the junk came from this source. It is indeed surprising that the pump continued to operate as long as it did.

# Increasing the Capacity of Boilers

By H. R. Callaway

*To meet the demand for boiler units of greater capacity it is suggested that the output of a horizontal water-tube boiler may be increased to approximately 300 per cent. by increasing the length of the first pass, and providing a large combustion chamber, with sufficient draft to enable a thick enough fire to be carried.*

Among the many factors to be considered in the design of a central station is the provision for as large a capacity as possible per square foot of ground area. This is particularly important when the station is to be located in a large city where ground values and taxes are high.

In the engine room great economy has been effected by the development of the steam turbine. Although the point most often advocated in its favor is its economy of steam consumption as compared to the reciprocating engine, the turbine's superiority is much more marked in the matter of space saving. Unfortunately, as yet there has been no parallel development for the boiler house, and if economy of space is to be attained in this part of the power plant, it must be accomplished with the present boiler equipment. To this end a great many plants have been designed with the boilers arranged in two and even three tiers, but it is impossible to go any further in this direction.

In view of these facts, it is evident that the logical way in which to increase a station's capacity is by forcing the boilers to handle much greater overloads than have yet been attempted. In some cases as high as 200 per cent. of rating has been developed with water-tube boilers operated by mechanical stokers and with forced draft, but with the present design such a rating cannot be attained in everyday operation.

In looking over the field of boiler equipment with this purpose in view, natural-draft outfits of all descriptions and also hand-fired boilers are at once eliminated. The possibility of forcing a boiler to 250 or 300 per cent. of rating with natural draft or with hand firing is remote. The amount of coal burned per square foot of grate for, say, 300 per cent. of rating, would probably amount to between 100 and 125 pounds per hour, and obviously no fireman could handle any such amount as this. Even if coal could be shoveled fast enough, it would be necessary to open the doors frequently, with a corresponding loss of efficiency through the introduction of cold air. Furthermore, in order to obtain a rate of combustion as rapid as this, it would be necessary to carry a very thick fire, and no chimney could furnish sufficient draft to burn coal at this rate unless the flue temperatures were very high, in which case the efficiency of the unit would be low and the object of forcing the boilers would be defeated. Therefore, in order to maintain such a high rate of combustion, forced draft and some method of mechanical stoking are essential.

As already mentioned, as high as 200 per cent. of rating has been obtained with ordinary settings. In certain tests in which this figure was reached a 650-horsepower Babcock & Wilcox boiler was fired by a gravity underfeed stoker with forced draft. Although the boiler was designed to deliver 650 horsepower, the baffling and combustion chamber being proportioned for this load, a rating of 1200 horsepower was reached with only a small drop in over-all efficiency. A set of curves plotted from these results show conclusively that a much higher rate could have been attained if the combustion chamber had afforded sufficient space in which to completely burn the hydrocarbons. There seems to be little doubt that the stoker could have been operated at a much higher rate with very little, if any, drop in the efficiency, but the boiler was undoubtedly taxed to its limit and the conclusion seems to be that alterations in boiler design would enable the same unit to be forced to an even greater extent. In the unit under consideration, the length of the first pass along the bottom tubes was 7½ feet out of a total length of 16 feet of tube. It might be practicable to increase this length to 9 feet, thus obtaining a 20 per cent. greater area of cross-section for the first pass.

In order to provide a larger combustion chamber the boiler might be raised two feet higher, which, in this case, would have given a 40 per cent. volumetric increase in the furnace. At 1000 horsepower the velocity of the gases through the tubes, although varying to some extent at different points, approximated 24 feet per second throughout. At double this horsepower, which would correspond to slightly more than 300 per cent. of rating with the same proportions of air and coal burned, and assuming that the efficiency remained nearly constant, the velocity of the gases would be about double, or 48 feet per second. If, however, the area of the first pass were increased as previously mentioned, this figure would be cut 20 per cent., giving a velocity at the entrance to the first pass of 40 feet per second. The second and third passes would of necessity be decreased in size, thus tending to produce a greater velocity in this section of the boiler; but, on the other hand, it has been well demonstrated that an increase of velocity of the gases is productive of an increased rate of heat transfer through the boiler tubes, in which case the gases would be cooled at a higher rate and their volume correspondingly diminished. Accordingly, the velocity at the back end of the boiler would probably drop to nearly the same rate as that obtained in the first pass.

Assuming that the increased rate of heat transfer was not proportional to the increased velocity in the first pass, the effect would be to make the middle and upper tubes of the first pass do a greater proportion of the work of evaporation than is the case at present. It is well established that between 75 and 85 per cent. of the evaporation in water-tube boilers of this type takes place in the first pass, and it is probably true that one-half of this amount is contributed by the two lower rows of tubes. In view of this, an increase in temperature in the upper part of the first pass would merely result in the upper tubes of the first pass and all the tubes in the second and third passes doing more nearly their proper share of the evaporation. If the velocity of the gases were greatly increased, as would probably be the case throughout the boiler, and the heat transfer increased, at least to some degree, it is scarcely likely that the flue temperature would be raised enough to seriously affect the efficiency of the unit. The increased velocity and greater volume of gas would increase the resistance offered by the tubes but this could be taken care of by a stronger draft.

In order to evaporate water at such a rate and consequently burn coal so rapidly, the fuel bed would probably have to be between 4 and 6 feet thick, which would make it necessary to have a greatly increased draft in any case. A fuel bed 3 feet thick has been successfully carried by the type of stoker used in the tests referred to with a draft of from 2 to 3 inches and there is no reason to doubt that one considerably thicker could be maintained. It would require experiment to determine with any degree of accuracy how great a draft would be required, but probably 8 or 10 inches of water would answer.

In Professor Nicolson's researches on heat transfer with increased velocity of the gases, he advocates draft-gage pressures of 20 inches of water, but these would be utterly impracticable as it would be impossible to keep the coal on the grates with such a heavy pressure. In the tests mentioned it was found that while the temperature of the combustion chamber varied very little under different load conditions, the temperature at the middle of the first pass varied, roughly, 200 degrees between normal rating and 100 per cent. overload. As this rise in temperature at the middle of the first pass was proportional to the rise in load throughout the test, it is reasonable to assume that the same law would hold up to 300 per cent. of rating. In this case, the temperature at the middle of the first pass would be 400 degrees higher than when the boiler was operated at 650 horsepower. This added temperature would make it necesary for the upper part of the first pass to do considerably more work, and it is scarcely probable that the temperature in the second pass would be much higher than under normal conditions.

It seems, on the whole, quite feasible to so arrange a boiler that it will absorb economically the heat evolved from coal burned at such a high rate. Then the problem would be to burn the coal with a good enough economy to make this excessive overload worth while. The impossibility of doing this with hand firing is obvious, and the stoker which will accomplish the desired result must not only furnish the coal at this tremendous rate but must also coke it thoroughly before it becomes ignited, in order that the hydrocarbons and other volatiles may be distilled off and pass through the zone of maximum heat in order to be completely consumed. Otherwise, smoke will result and with it a loss of efficiency.

The necessarily intermittent operation of hand cleaning with its checking of the fire could not be permitted, so the stoker, to meet these conditions, must be of the self-cleaning type and the ashes must be removed without the admission of cold air. As the whole object of the scheme herein outlined is rapid and continuous operation, the importance of automatic cleaning of the stoker grates is evident.

The phase of this problem, which is not only the most difficult but also the most important aside from the stoker design itself, is that of securing the proper proportions of air and coal. As the amount of coal fired per hour is increased, the amount of air should be automatically controlled in such a way as to increase proportionately; that is, if the allowable amount of excess air has been determined upon for the coal used, it should be possible to so arrange the mechanism of the stoker that this ratio of excess air is maintained constant regardless of the load conditions. This is a problem the solution of which has not heretofore been reached for these extreme conditions because such overloads as those considered have not been tried.

# Design of Steam Power Plants

By William F. Fischer

*Factors to be considered when designing a power plant, including the selection of a site, the construction of foundations and building and utility of general layout.*

### Location of Plant

After the available capital has been determined, one of the first questions to be decided is the location of the plant; this depends upon several factors. In order to avoid danger from floods, the plant should be located at a suitable elevation above high-water level. The ground should be nearly level with ample room for future extension, coal storage, outbuildings, etc.; and as all extra blasting, piling and concrete-foundation work involve a considerable expense a site is desirable where excavations can be made readily at minimum cost. Where firm hard-pan, clay, gravel or rock is found within a few feet of the surface and where only slight grading is required, the cost of foundation work may be kept within a reasonable figure. Piling on soft or marshy ground is necessarily expensive, and causes more or less anxiety as to the security of the structure.

There should be an abundant and never failing water supply for boiler feed and condensing purposes, and this water, especially that for boiler feeding, should be pure and, if possible, free of cost, except for pumping. A water-side location is preferable, with a pumping head not over 18 to 20 feet.

The fuel supply must be absolutely reliable and should be delivered to the premises, at the lowest rates attainable by rail or boat, in order to prevent the additional expense of carting. In certain sections of the country it is not well to depend altogether upon river transportation, as there may be seasons when the river is either too low or too swollen, making navigation difficult or impossible. It is well to make arrangements, if possible, with the nearest railroad to run a spur to the plant or, better still, the plant may be located near both a railroad and a waterway.

Sufficient storage capacity is essential so that a full supply of fuel may be procured during the season of lowest prices. By this practice much money may be saved. As an extra precaution this storage capacity should be sufficient for the winter load or to carry over a period of any long strike that may occur at the coal mines or on the transportation lines.

The cost of removing ashes from the plant, whether by rail, water or cart, is another factor to be considered.

An important factor governing the location of the plant is the ease with which power may be transmitted from the generating source to the point of demand. In the case of electric-light and street-railway plants, the most desirable location is, undoubtedly, the electrical center of the entire district to which power and light is supplied, providing the location is convenient in the other respects heretofore mentioned.

Another point to be considered is the fire risk. In this connection the surroundings should be investigated with a view to ascertaining the liability of fire from adjacent buildings.

### Type of Plant

If there is a probability of the plant being enlarged in the future, the best arrangement is to place the engines and boilers back to back in parallel rows with a division wall between, separating the engine and boiler rooms. With this arrangement the steam piping is direct and the main steam header may be made comparatively small and be divided into units by placing valves at proper intervals. Then part of the header can be shut off whenever necessary without interfering with the successful operation of the station. Where the engine and boiler rooms are placed end to end the steam main may be inadequate if additional engines are added at one end and additional boilers at the other. Also, to accommodate the additional units the plant must be extended in both directions, thus greatly increasing the cost.

As a rule, the boiler-room floor is on a level with the outside ground, and the engine-room floor, especially where large engines are used, is usually from 6 to 10 feet above the boiler-room floor, with a basement beneath it. Where the engine-room floor is on a level with the outside ground, it is necessary, where no basement is provided, to build a pit for the condenser and construct pipe trenches for the exhaust steam and circulating-water pipes. Where large engines are employed it may be necessary to construct

a pit for each flywheel. Such pits, however, ought to be avoided wherever possible, as the vibrations of the engines tend to cause the concrete lining to crack and allow water to enter the pit. Pipe trenches should also be avoided, for the pipes are not as accessible as when suspended from overhead beams in the engine-room basement.

In large plants a basement is usually provided under the boiler room for the accommodation of pumps, blowers, air ducts, etc. The boilers in such cases are usually equipped with ash spouts, leading to the basement where the ashes are emptied directly into ash cars or conveyers.

Where land is cheap, very little consideration is given to compact arrangements, but where land is expensive, it is sometimes necessary to place the boilers on two or more floors, one above the other. An example of this kind may be seen at the Metropolitan street-railway power station at Ninety-sixth street and East river, New York City, where the boilers are placed on three floors, one above the other.

### The Building

The building should preferably be of fireproof construction, the walls being of brick, concrete or stone, and the interior faces finished smooth or painted. The finished wall may be painted or calcimined with cold-water paint, although in some large stations glazed tile is used.

No wooden ceiling or sheathing should be permitted in power-plant construction. However, brick walls with steel trusses supporting a wooden roof covered with tar and gravel, or with some fireproof material, is the practice in many of the smaller stations. Metal roofings should be avoided as they entail a cost for painting and maintenance not incurred with a slate, tile or concrete roof; but in all cases a tile roof laid in cement or concrete is to be preferred.

In the smaller stations the roof trusses and tracks for traveling cranes are frequently carried directly by the brick walls of the building, but in the larger stations these are always supported by steel columns resting on their own foundations, the walls carrying only their own weight. Concrete floors with a granolithic finish are usually laid around the engine foundations and vitrified brick laid in a bed of concrete is very durable for boiler-room floors on to which hot cinders are frequently raked from the ashpits.

In all cases it is preferable to separate the engine and boiler rooms by a division fire wall. Doors in this wall should be of the self-closing, "underwriters' pattern," hung on sloping tracks or hangers. Doors of this type may be placed on one side of each door opening (preferably the boiler-room side), and held open by fusible links, which melt or fuse at a certain temperature. All windows exposed to fire from without should be protected by suitable fireproof shutters. Fire hydrants should be provided at suitable points, both outside and inside the building, with adequate lengths of hose in accessible places and connected at each hydrant ready for immediate use.

The building should be designed to conform to the equipment and in no case ought the mechanical layout to be cramped to suit the building conditions, unless absolutely necessary. Utility is the primary consideration in power-plant design and architectural features secondary. In designing a power plant care must be taken to provide one or more doors of sufficient size to admit the largest piece of machinery, or the largest part of a machine; otherwise it may be impossible to get the machinery in and out of the building.

Ample space is essential around all engines, pumps and similar machinery so that the pistons may be removed without moving the machines from their foundations. A clear space of sufficient width to remove the tubes is necessary in front of each boiler. Where it is absolutely necessary to economize in space in front of the boilers, large windows may be placed in the wall, one in front of each boiler, and of such size as to permit the removal of the tubes. A space 4 to 6 feet wide should be allowed between the backs of the boilers and the nearest wall. This space is necessary in order to get at the blowoff piping and the cleanout doors.

If economizers are to be installed, sufficient space must be provided for their operation, cleaning, repairs, etc. Sometimes, however, separate housings are provided for economizers.

To avoid mistakes, the building plans and specifications should not be completed until all the important points of the mechanical layout are decided upon and approved by the owner or engineer in charge of the work.

### Foundations

With but a few exceptions all soils become compressed under the weight of a building, and allow the building to settle a certain amount. Therefore, the main object is not to prevent settling entirely, but to insure its being uniform.

As many soils, such as sand, gravel and clay, may vary greatly within a comparatively small area, it is well to determine its character and bearing power at several different points by borings or excavations. The building code of New York City specifies the following as the maximum permissible loads per square foot for different soils. Soft clay, one ton; ordinary clay and sand together, in wet and springy layers, two tons; loam, clay or fine sand, firm and dry, three tons; firm, coarse sand, stiff gravel or hard clay, four tons or as otherwise determined by the commissioner of buildings. Sand, if confined or kept from spreading, will support safely a considerable load, as shown by an experiment made some time ago in France, where clean river sand which was tamped in a trench and kept from spreading supported safely 100 tons per square foot.

When proportioning the foundations in power-plant work, several practical considerations must be taken into account. For example, the allowable pressure on the soil per square foot of area is considerably less for tall chimneys and similar high structures than for low massive structures; for, in the former case, any slight inequality of bearing power and consequent unequal settling might endanger the stability of the structure, while in the latter case no serious harm would result.

All machinery foundations should be constructed absolutely independent of the walls of the building; but where two or more foundations for individual units are within a short distance of one another, they may be bonded together, in which case the combined mass and increased area will render them more capable of withstanding greater strains. If loose rock is found when excavating, it should be removed, and all solid rock, unless absolutely level, should be dressed off in steps with vertical risers and horizontal treads so that the pressure will be exerted everywhere in a vertical direction. Solid rock may support almost any load likely to be imposed upon it, but care should be taken in order that the load per square foot of surface does not exceed one-eighth of the crushing strength of the rock.

Where the soil is of a yielding nature, piling or grillage must be used to support the foundations. Spread foundations of reinforced concrete are frequently used in place of piling where the foundations are spread over a large area, but where the ground is very soft and marshy, piles should always be driven to support the foundations. The durability of piles in ground constantly saturated with water is beyond question, as piles have been found in a perfectly sound condition after the lapse of many centuries. All piles should be driven to rock or hard-pan, or to an even bearing until capable of supporting the loads imposed upon them.

In modern construction, the ground is excavated between the heads of the piles to a depth of one or more feet and the piles capped with a bed of concrete. Steel reinforcing rods may be embedded in the concrete if it is thought necessary, to increase the strength of the concrete foundations.

All holes for the foundation bolts should be accurately located by templet, leaving sufficient space around the bolts for a slight variation in the location of the machinery. After the machinery is set in place, the space around the bolts may be filled with a cement grouting.

# Gas Power Department

*Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men*

## The New Ajax Engine

The new Ajax gas engine, illustrated herewith, represents a combination of progressive ideas in design and construction derived from long experience in this class of work. The entire Ajax line* has been redesigned and the scope extended to include tandem construction, as indicated in Fig. 1.

The longitudinal and cross-sections, Figs. 2 and 3, show the constructional details of the frame, cylinders and valves fairly well. The front cylinder is fitted to the frame with a liberal flange and neck and is supported on a pedestal which is free to slide on the sole plate. As the front piston serves as a crosshead, it is made longer than the rear piston and the cylinder is also extended forward to provide a correspondingly long bearing surface. The rear cylinder is exactly like the front one except for this forward extension, and the valve cages of the two cylinders are therefore interchangeable. Consequently, in case of any accident which might disable one of the rear valves, the corresponding valve and cage on the front cylinder could be transferred to the rear one and the engine operated with the front cylinder cut out. Or, if spare parts are carried in stock, one valve and cage will fit either cylinder. The damaging of a valve cage is a very remote possibility, but the feature of interchangeability is much like the Texan's gun during the period of regeneration—useless most of the time but more precious than a diamond mine when the occasion did arise.

The rear cylinder is mounted on a pedestal exactly like the front one. The distance barrel between the two cylinders is made with openings large enough to allow the stuffing box in the front cylinder head to be removed without disturbing the general structure. The distance barrel is split lengthwise and attached to the cylinders by bolts (instead of studs and nuts; consequently, it can be taken out entirely, giving access to the rear piston and cylinder and allowing the head of the front cylinder to be removed, without disturbing any of the pipe connections or cam-shaft mountings.

The piston-rod stuffing box is split lengthwise into two equal parts and held together, independently of the pocket in the cylinder head, by transverse fillister-head screws. Fig. 4 illustrates this construction. The half box at the left is

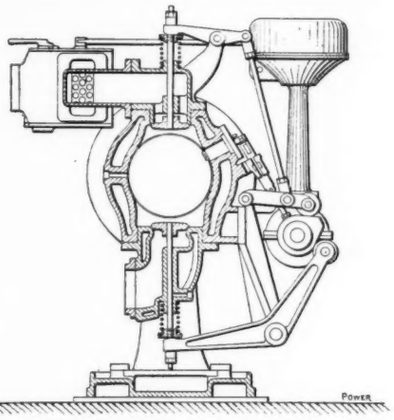


FIG. 2. CROSS-SECTION OF AJAX ENGINE

shown with the rings in position. These are of rather unusual construction. Each main ring is made with a circular recess around one edge and a small ring of square cross-section fits into this recess, the two forming a compound ring. Both the inner and outer members are cut into three equal pieces after being turned to size, and the inner ring is doweled in

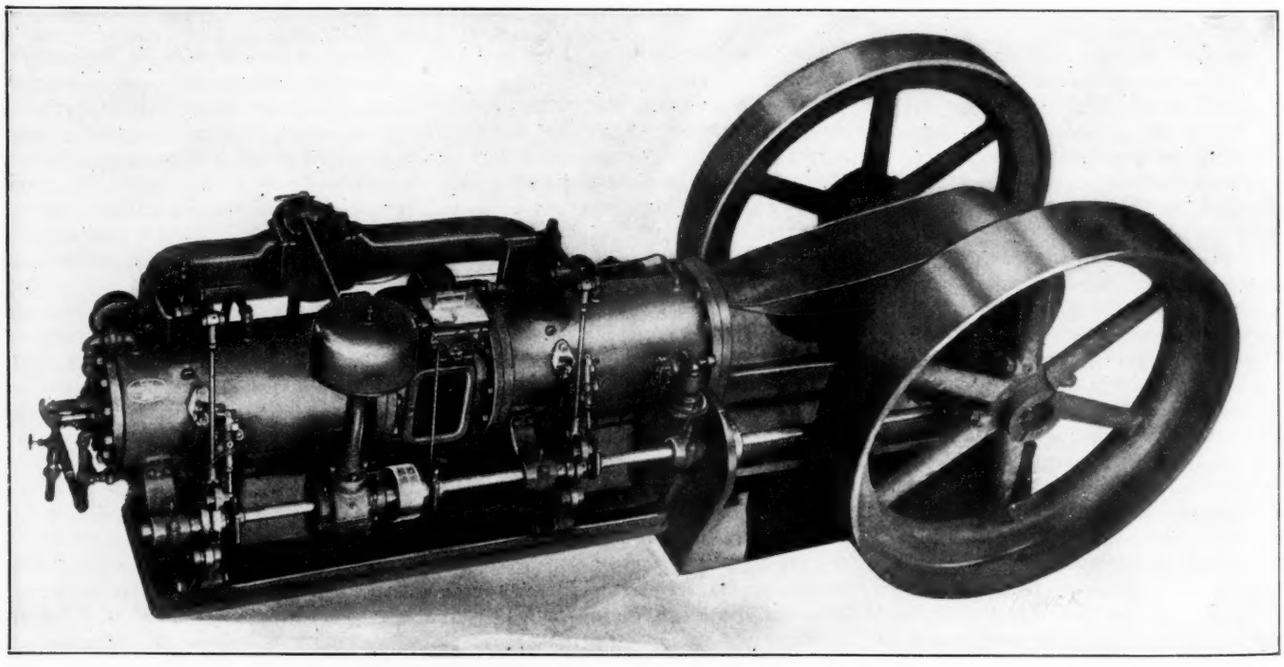


FIG. 1. TANDEM SINGLE-ACTING AJAX ENGINE; NEW TYPE

*Built by the Ajax Iron Works, Corry, Penn.

its recess in such a position that the three cuts in it do not come in line with those in the outer ring. A coil spring around the outside of the outer ring clamps the parts around the piston rod.

The construction of the piston and rod is shown in Fig. 5. The ends of the rod are turned down to form long necks, which are threaded at the ends, and the shoulder where the diameters change is beveled to 45 degrees. This bevel fits a 45-degree seat at the mouth of the hole in the front piston and in a flange which is bolted to the rear piston; this flange, or cap, is shown separately at *F*. The rod and flange are held together by a heavy nut which is held in place by a set screw, and the rod is held snugly in its seat in the front piston by a similar nut. This construction, it will be noted, relieves the screw threads of all stresses due to the working pressures; the only work the threads have to do is to pull the rear piston forward idly during the suction strokes—the beveled shoulders take the thrusts of explosion and compression.

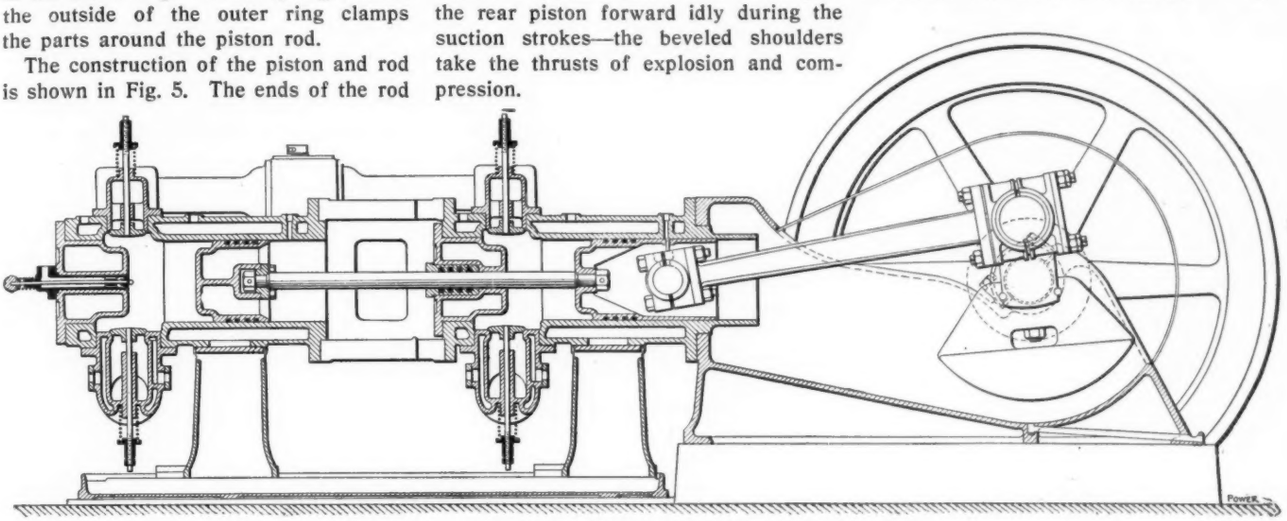


FIG. 3. LONGITUDINAL SECTION OF AJAX TANDEM ENGINE

The connecting-rod construction is so clearly shown in Fig. 3 that description is unnecessary. A practical feature of the crank-pin box is that the two parts are exactly alike and therefore interchangeable. The balancing weights of the crank are fastened to the ends of the crank cheeks by massive studs and nuts, and the nuts are housed in a little pocket in the weight, as shown in Fig. 3.

The valves are of the ordinary poppet type, with the heads slightly crowned. They are opened by the usual arrangement of cams, rollers, push rod and rocker arms. The exhaust-valve cage is water-jacketed very thoroughly, as Figs. 2 and 3 show, and the walls are of uniform thickness at all points. Fig. 6 shows the inlet and exhaust valve cages, complete with valves and springs. The mixing chamber is located midway between the inlet valves of the front and rear cylinders, as may be seen in Fig. 1, and contains a combined mixing and throttling valve which is controlled by the governor. This valve is of the multiported cylindrical form and is oscillated by the governor to vary the port openings according to the load demands. A plug cock in the gas entrance to the mixing box is adjusted by means of a handle to get the proper proportion of gas to air.

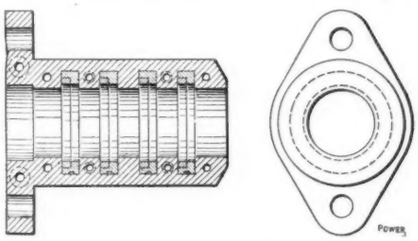


FIG. 4. PISTON-ROD PACKING

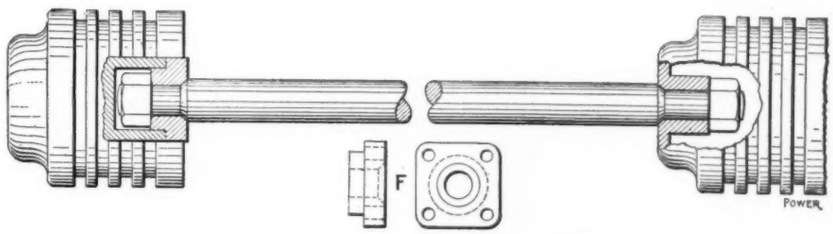



FIG. 5. AJAX PISTONS AND PISTON ROD

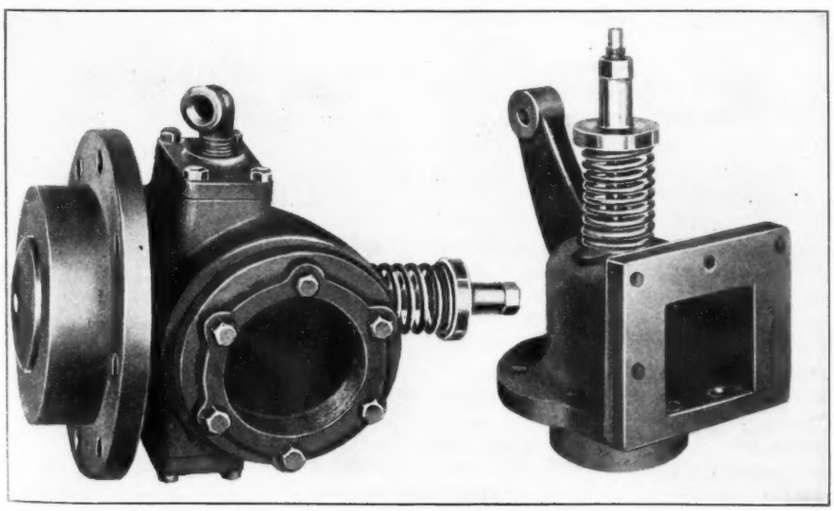


FIG. 6. EXHAUST AND INLET-VALVE CAGES AND VALVES

The governor, Fig. 7, is a modification of the Hartung type and is provided with a thumb-screw adjustment by means of which the speed can be changed while the engine is running. It is gear driven from the cam shaft.

Make-and-break igniters are used and they are of the simple mechanical type, tripped by cams and push rods. Current for the igniters is supplied by a magneto generator, which is mounted on a bracket on the side of the forward cylinder and is belt driven by a pulley on the cam shaft; this arrangement is shown in Fig. 1.

The minor features of the engine which reflect care and forethought on the part of the designer are these: The engine frame, which is of the double-wall box

type, is provided with an oil groove all around the bottom edge to catch waste oil from the various bearings; the water jacket of the exhaust-valve cage is so constructed that the cooling water enters near the bottom on one side and must

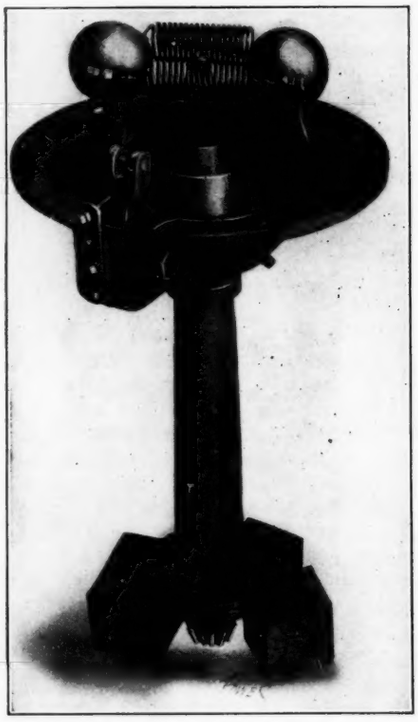


FIG. 7. THE GOVERNOR

pass upward to the top of the valve before it can get out; all wearing parts of the governor run in an oil bath; the mixing and throttling valve is mounted on ball bearings and copious lubrication is provided between the periphery of the valve and the wall of its cage; the cam shaft is divided into sections, coupled together at points corresponding to divisions in the main structure; all of the moving parts are on one side of the engine and all of the piping is on the other side; all

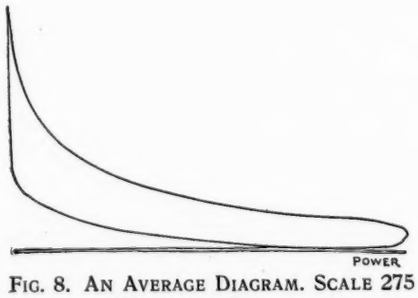



FIG. 8. AN AVERAGE DIAGRAM. SCALE 275 POUNDS AS PRINTED

cams, rollers and pins are hardened; every pair of rubbing surfaces is lubricated, including pivot pins and rocker hubs; the proper settings of the ignition timer and the gas cock for starting and running are marked plainly on those parts; an auxiliary safety attachment on the governor will cut out the ignition current if the speed should go beyond the maximum advisable rate; either cylinder can be cut out of action while the engine is running, leaving the other cylinder to do all the work. This last-named feature is of more value than it might appear upon first thought. In places where an engine has to carry less than half load for a considerable part of the day, cutting out one cylinder during that part of the run effects a very important saving of fuel.

The indicator diagrams, Figs. 8 and 9, are representative of the performance of the engine; they were selected by the writer from a large number of diagrams in preference to some which were more symmetrical but which did not truly represent average performance, as these do.

The engines are built in single-cylinder form for small outputs, single tandem form for medium sizes and twin tandem for the larger outputs.

## A Narrow Escape from Gas Poisoning

According to a New York daily newspaper, the night engineer of the Newton (N. J.) Gas and Electric Power Company recently had a narrow escape from death by gas poisoning. The story is to the effect that the engineer, who was alone in the power house, was taking a reading of the gas pressure in the main when he felt the sudden dizziness and weakness in the knees and back which indicate dangerous poisoning by carbon-monoxide gas. Realizing what these symptoms meant, he managed to crawl to the telephone, call up the day engineer and gasp "Help" in the telephone, before he lost his senses.

The day engineer, fortunately, recognized the voice and after getting into as few clothes as he could venture out of doors in he rushed over to the station. He found the night engineer unconscious

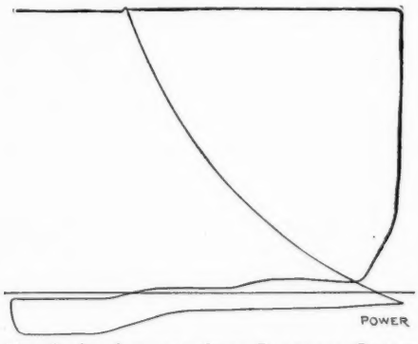



FIG. 9. AN AVERAGE STOP DIAGRAM. SCALE 13.6 POUNDS AS PRINTED

near the telephone, dragged him out into the fresh air and summoned a physician to attend him. Then he had the gas shut off the main that supplies the power house.

After two hours of hard work, the doctor succeeded in reviving the night engineer, and he has entirely recovered from the effects of the poisoning.

# LETTERS

## Sounds in Gas Engines

A knock in a gas or gasolene engine is often extremely hard to locate, as the same sound can be generated in several ways. A loose flywheel is sometimes responsible; yet it may be that the ignition is advanced too far, or there is preignition from incandescent carbon, short-circuits or an overheated engine due to derangement of the cooling system. Lack of lubrication or using the wrong oil will cause a knock, but it is not such a distinctive sound as something loose or broken. Too rich a mixture or water in the combustion chamber will often cause uneven running which produces a sound that slightly resembles a knock.

Worn bearings will frequently cause an engine to pound in a most alarming way. Care should be taken not to set up a badly worn bearing too much; there is danger of throwing the whole shaft out of line and ruining the remaining bearings.

Sometimes when the compression is not uniform in all the cylinders of a multicylinder engine it appears to have a slight knock while in reality it has not; the cylinders with the better compression give stronger power strokes than the weaker ones, and this causes irregular running which is usually attributed to loose parts.

Hissing sounds are mostly due to loose igniters, loose or broken spark plugs, a cracked exhaust pipe, looseness in the exhaust manifold, open compression-relief cocks or worn gaskets.

The correct amount of good oil in the cylinders and bearings and plenty of hard grease or graphite paste in the gears and on other rubbing parts will prevent wear and the resultant noises.

A. L. BRENNAN, JR.

New York.

The largest installation of Diesel engines yet ordered is that which is being built by Franco Tosi, of Legnano, Italy, engineer, and he has entirely recovered. for the city of Rome. The order comprises two Diesel engines of 1000 horsepower each, and three of 2000 horsepower each, to operate on the two-stroke cycle. The engines will run at 136 revolutions per minute and be direct connected to three-phase generators of 8200 volts. The contract includes the operation of the engines for ten years by the manufacturers. The plant will furnish electricity for the city, pending the development of the water power of the River Aniene, which will not be completed for a couple of years, and probably used as a standby after the completion of the hydraulic works.

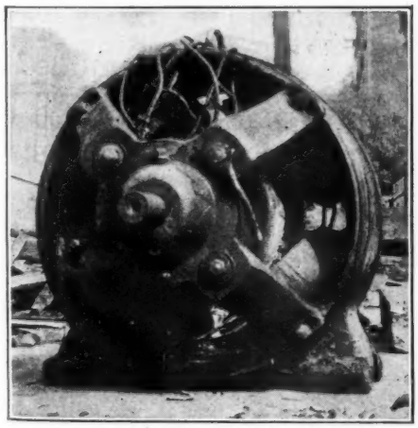
# Electrical Department

*Especially conducted to be of interest and service to the men in charge of the electrical equipment*

## Through Fire and Water

Electrical apparatus is generally considered to be less rugged than some other classes of machinery, but the accompanying illustrations indicate that it can pass through severe ordeals without irreparable damage. The pictures are those of two Bullock motors taken from the ruins of the *Los Angeles Times* building. After the explosion and fire which recently destroyed the building these motors were removed from the basement where they were lying in five feet of water. The printing presses to which they were attached were completely destroyed and had no value except as scrap iron. The motors, however, were not badly damaged and were practically the only articles of value saved from the ruins. In the adjustment of losses made by the Fire Underwriters Association, 99 per cent. of the total insurance was allowed, the 1 per cent. saving being based almost entirely on the value of the motors. The insulation of the machines was destroyed, but the commutator bars and cores, brush holders, bearings and frames were in good condition.

SIXTY-HORSEPOWER DIRECT-CURRENT MOTOR AS IT CAME FROM RUINS



TEN-HORSEPOWER DIRECT-CURRENT MOTOR AS IT CAME FROM RUINS

The motors attracted considerable attention and excited much comment because of the fact that they were the only pieces of machinery saved from the ruins. The larger motor is a 60-horsepower, 500-volt machine, and the smaller one is a 10-horsepower machine. They are now being rewound in the shops of the manufacturer and will be used to drive new presses in the new building which is soon to be erected.

## The Fan Motor in Winter

It is the popular opinion that the range of usefulness of the electric fan motor is limited to the summer months and that its sole utility lies in its application as a means of reducing the temperature of a room or an office. This is not true, however, and slowly but surely the public is beginning to understand that the usefulness of the fan motor is by no means confined to the hot days of summer, and that, paradoxical as it may seem, the electric fan blows hot or cold; and incidentally while it is blowing hot it cuts down the fuel bill. Following are a few of the more important applications of the fan motor to winter use:

The efficiency of the hot-air heating system may be greatly increased by placing a fan motor in the cold-air box to force the air through the registers to all parts of the house. On particularly cold days, when the wind is so strong that it forces the air through the furnace into the rooms without having become heated, a fan motor placed in the cold air box, after having closed the slide which permits air to come in from the outside and opening the slide which lets the air in from the cellar, will cause an appreciable rise in the temperature of the room, without making any increase in fuel consumption.

As is very often the case, the house contains one or more rooms which under certain conditions are difficult to heat. This difficulty can be overcome by placing a fan motor in front of the hot-air register, or over it in case the register is located in the floor. This plan will prove more efficient if the register and fan motor are covered by a box or hood of some kind which will cause the fan to draw air from the pipe only, and not from the room.

Another service to which the fan motor may be applied to advantage in winter is preventing the accumulation of frost on the show windows of stores. The air from the fan motor directed against the glass of the window will keep it practically free from frost. This application of the motor is a boon to merchants who have heretofore lost during cold weather practically all the advantage which their window display would have afforded them.—*G. E. Review.*

## An Excessive Magnet Drag

BY RICHARD CLEMENS

We have at our power plant a 200-kilowatt, direct-current, 250-volt Thompson-Ryan generator, direct connected to a 20x22 McEwen simple automatic engine, running at 180 revolutions per minute. This dynamo has 14 balancing field-magnet coils, with 14 other field coils, making 28 coils in all. When the dynamo was installed we had an experience which may interest some readers of POWER.

The installation of the plant being complete, we began an acceptance test of the engine and generator, using three large barrels filled with salt water as a rheostat to put the load on the generator. The engine was started, and everything seemed to be going very satisfactorily. The voltage stood at 250 with no load, and compounded to 270 as the load was increased up to 700 amperes. After running for an hour or little more, the water in the barrels began to foam and boil over, and in adjusting the terminals to reduce the load, an attendant accidentally short-circuited the generator, which knocked out the circuit-breaker. The engine regulated well, but when the breaker was reclosed the voltmeter showed only 200 volts.

Careful tests showed that the speed was normal, the brush yoke was in the proper position, the rheostat in the field circuit was undamaged and the connections were all sound. Then we began a systematic search for the trouble. We investigated the various connections around the machine, the commutator, the

armature leads; in fact, everything but the right one. The magneto showed no grounds of any kind, or short-circuits. Finally, we tested the polarity of the entire twenty-eight field-magnet coils, not once but several times; but nothing was wrong with the polarity. For two days we kept this up, trying first one thing and then another. We called up the manufacturers, for they had a representative there to see the test, but their suggestions did not remedy the trouble.

On the following Sunday morning I got into communication with an old friend who had been on the road for years and, fortunately for us, he had had a similar experience. He advised us to take the machine apart and examine the dowel pin which holds the field coils in position. This pin is situated right at the bottom of the yoke ring and in order to get at it we had to remove the armature; sure enough we found the pin bent almost to a right angle. The heavy armature current due to the short-circuit when changing the terminals at the water rheostat had reacted on the field magnet with sufficient force to bend the pin and shift the position of the whole ring of coils. We replaced the bent pin with two of larger size, at the same time wedging each coil by placing a liner behind it. When the machine was put together again and driven at normal speed, the voltage went up to 250, and when the various loads were put on, the machine compounded perfectly.

# CORRESPONDENCE

## "Be Sure You're Right," etc.

The incident related in a recent issue of POWER about the sweeper advising the engineer to pull the generator switch instead of using a brake on the engine flywheel reminds me of a somewhat similar scrape the other fellow got into once. In this plant, which is combined hydraulic and steam, we have a little trouble in pulling our peak load with water power alone, and in conjunction have a cross-compound condensing engine driving a 500-kilowatt generator and exciter to tide us over the rush. The main-drive pulley on the line shaft runs on a quill; so does the generator, both being connected by clutches to the main shaft. The exciter is belted direct to the main shaft.

One evening as the peak-load period was approaching, the engineer started the engine and coupled it to the main shaft, and this started the exciter. Overlooking the generator clutch, he went to the switchboard and put the exciter in parallel with the one already in service. Then he closed the generator-field switch, but with all the resistance cut out of the rheostat the voltmeter would not budge. Supposing that the fuses on the transformer were out of business, he proceeded to test them out, but found them all right. He pounded on the voltmeter with his fist until the glass cracked, but the hand still refused to move. By this time the load on the waterwheel had increased until the speed had dropped off so the lights began to get dim, but pulling his hair produced no useful results. The superintendent fortunately arrived on the scene about then and advised him to throw in the generator clutch.

ABE FOUT.

Iowa City, Ia.

## Identifying Alternating and Direct Current

Referring to H. Priestley's query on this subject, in the December 6 issue, I suggest that by attaching to the socket a plain carbon-filament bulb, turning the current on and holding one pole of a magnet close to the bulb, he can tell what kind of current is flowing in the circuit. The lamp filament will be attracted or repelled (according to which pole of the magnet is used) and will remain in the attracted or repelled position until the magnet is withdrawn, if the current be direct current; the filament loop will vibrate toward and away from the magnet if the current be alternating.

Another simple test, if no magnet is available, can be quickly made by screwing an attachment plug in the socket instead of a lamp and submerging the two terminals of the plug cord in salted water. If the current be direct, one of the terminals (the negative) will gas freely. A lamp should be connected in series with one conductor of the plug cord to prevent accidental short-circuiting.

There are in the market several inexpensive testing contrivances, but when these are not on hand just as positive results can be obtained by the methods described.

ALEX. DOLPHIN.

Jamaica, N. Y.

There are several ways to determine whether the current in a lamp socket is direct or alternating. One way is to hold the poles of a horseshoe magnet close to the lamp bulb. If the current is direct, the filament will be drawn toward one of the magnet poles; with alternating current, the filament will vibrate between the two magnet poles. Another way is to wet a spot on a white pine board and stick the ends of two wires in the wet place about two inches apart, the wires being connected to a plug inserted in the lamp socket. If the board turns green around one of the wires, the current is direct and the wire producing the discoloration is positive in polarity. If there is no discoloration, the current is alternating.

If there are any arc lamps on the circuit it is easy to tell which kind of current is passing. Direct current will produce a blue tinge at the upper part of the arc and a pure white light below it. But this, of course, is not identifying the current at the lamp socket, as Mr. Priestley wishes to do.

An ordinary pocket compass also will indicate the character of the current. It is only necessary to place the compass on a wooden table or box, away from any large pieces of iron or steel, and hold a wire horizontally above the compass, parallel to the normal position of the needle. Direct current in the wire will deflect the needle to one side; alternating current will either cause it to quiver or have no visible effect on it—probably the latter. The wire can be one of two leads from the circuit to an incandescent lamp.

J. E. BATES.

Spokane, Wash.

[The foregoing letters were received before the January 3 issue went to press, but not quite early enough to be printed with the other letters on this subject that were published in that issue.—EDITOR.]

## Static Electricity around Printing Presses

Will some readers kindly suggest through this department of POWER the most practical way to overcome the static electricity that causes so much bother around printing presses?

A. W. FISH.

Argos, Ind.

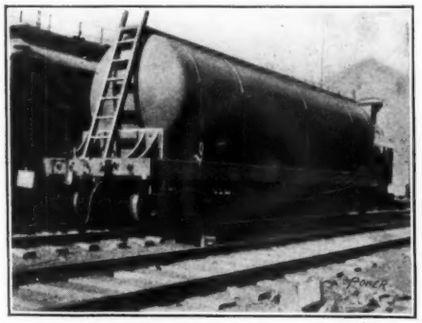
Some figures are given in the annual report of the electricity department of the Manchester Corporation which show the progress made in recent years toward cheapening the engines, boilers and other machinery and plant used in the generation of electricity. For example, the costs per kilowatt erected at Dickinson street, Bloom street and Stuart street stations are respectively $98, $84.50 and $85.50. Most of the machinery at Dickinson street is not that originally erected in 1894. On the basis of the old machinery the cost would have been much higher. A reason for the exceptionally low cost at Stuart street may be found in the two large turbines there, which are considerably cheaper than reciprocating generating sets. Stuart street has also the advantage of large units, which means economy both of capital outlay and fuel and operating costs. Thus the fuel cost per unit generated is 0.288 cent at Stuart street and 0.394 cent at the other two stations. The total operating costs, including repairs, but not capital charges, are respectively 0.428 and 0.690 cent. Distribution, management and capital costs must, of course, be added, the total cost per unit averaging 2.28 cents, and the revenue 2.52 cents. Excluding capital charges, the total cost amounts to 1.22 cents. —*The Engineer.*

# Readers with Something to Say

*Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted*

## Welded Steel Products

The tank shown in the accompanying illustration was made in Germany, and is used for the transportation of compressed Pintsch gas, used for lighting railroad coaches, the pressure carried ranging from 18 to 20 atmospheres. A riveted tank cannot be used for this work, as the constant racking and straining cause leaks which would be very serious in handling an inflammable gas. The tank is made of heavy plates with welded joints and the cost of manufacture is approximately the same as with riveted work, while the resulting product is infinitely superior. Welded work of this character is not a new product, but has been turned out in Europe for the last ten years, extremely complicated shapes being produced, while in the United States there is to my knowledge



WELDED-STEEL TANK CAR

no concern able to produce work of this kind.

In Europe, plate welding has advanced to the stage where nothing is too difficult and it is used for the production of seamless cylinders and tanks of any practicable size. The water legs of boilers are readily produced; sulphite digesters, used in paper-plup mills, of one-inch plate have been made 7 feet in diameter by 30 feet long, and larger. The bodies of buoys to be charged with compressed gas and which serve as floating beacons are another product of the plate-welding process, which is also used for producing corrugated fire boxes and boiler flues with the Galloway tubes welded in place. Steam headers and the military masts for warships, ornamental electric light and trolley poles, are other products, as are seamless tank cars for the transportation of fluids and the rotary kilns for cement mills.

In this country the welding of plates has been guarded as a secret process by the one boiler-making concern which uses this method of manufacture. The process has been closely guarded and the concern has been blindly asleep to the fact that an extension of the process was feasible to other parts of its boiler, and with the proper plant would cost them less than their present riveted work.

Besides, there is no real secret about the process they use.

Over ten years old, and nothing doing yet, in America.

WILLIAM DENISON.

Cleveland, O.

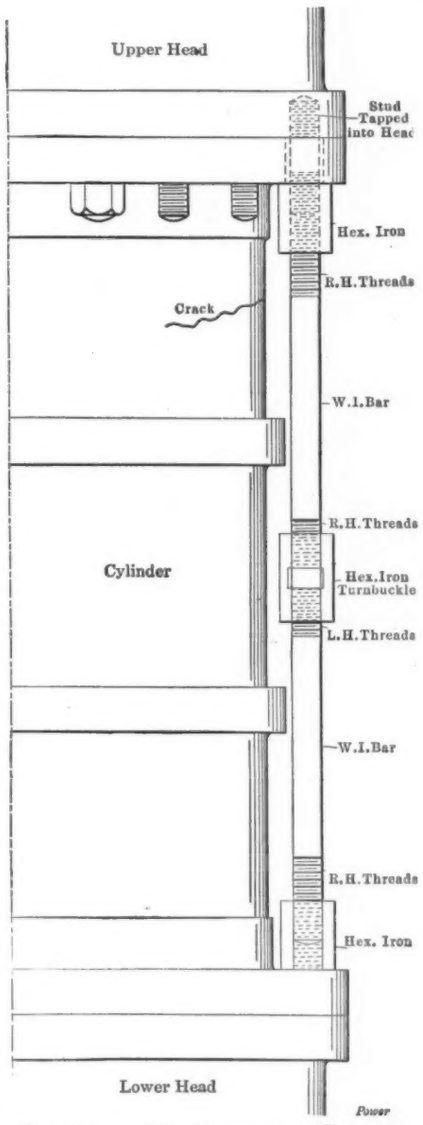
## Reinforcing a Cracked Steam Cylinder

A rather novel repair of a transverse crack in the outside shell of a steam-jacketed, high-pressure cylinder of a vertical, triple-expansion pumping engine, working under 180 pounds steam pressure, and carrying this same pressure in the jacket, was carried out as follows:

In this case the heads were secured to the cylinder by means of studs tapped into the cylinder heads, and the problem was to tie the two heads together, with the cylinder between them without shutting down.

First wrought-iron bars of the same diameter as the studs were cut so that the combined length of any two of them was about an inch less than the distance between the projecting ends of a stud in the upper head and the one in line with it in the lower head. These were threaded as shown in the accompanying illustration.

Next some hexagonal iron pieces, of the same size as a United States standard nut for this size bolt, and a little more than twice as long as the hight of a standard nut were tapped to fit the studs and the bars. Finally turnbuckles were made of the same size hexagonal iron and tapped for right- and left-hand threads. Then, after screwing one bar into each end of the turnbuckle far enough to make the total length of the three pieces about equal to the distance between the ends of the studs, and screwing one of the hexagonal iron pieces onto the other end of the bars until the ends came flush with the hexagonal iron pieces, the whole was put in place and the hexagonal iron pieces screwed onto the studs, thereby partly unscrewing them from the bars. This had the same effect on the gaskets as the original nuts had. Finally, by turning the turnbuckle, the desired strengthening effect was obtained and the cylinder has not given any trouble since.



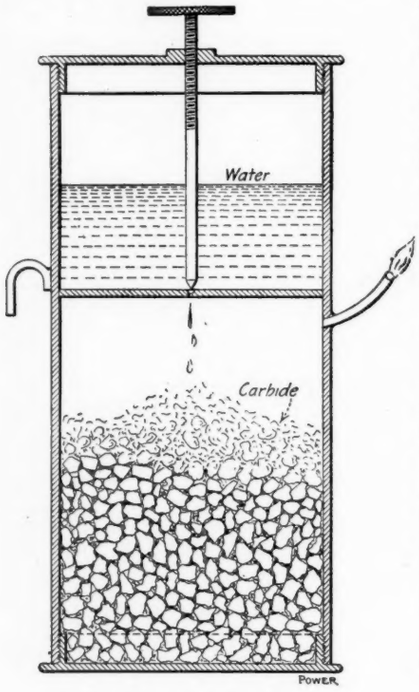

METHOD OF STRENGTHENING CRACKED CYLINDER

L. C. BROECKER.

Buffalo, N. Y.

## Acetylene Gas Lamp

The accompanying sketch represents a cross-section of a carbide-gas lamp that is very handy around the engine room. It was made from a piece of 1¼-inch brass tubing. The top and bottom caps and water stem were taken from the top of two old glass oil cups, the hole in the bottom cap being plugged. The burner




SECTION THROUGH LAMP

is a small piece of brass pipe taken from an old lubricator, and the hook is a piece of copper wire. The lamp will burn about two hours with one filling of carbide.

E. A. HEINY.

Springfield, Ill.

## An Experience in Boiler Cleaning

On taking charge of an electric-lighting plant, in which were three 72-inch by 18-foot horizontal return-tubular boilers, I found them in bad condition. The best of the three boilers was badly scaled, but was capable of carrying the load alone, except on Saturday night. Either of the other two could carry the load Sunday night and until the lighting load came on Monday night.

The feed water was so bad that a boiler had to be washed after each week's run. Because of these conditions it was the custom to run the best boiler, No. 3, during the week, fire up one of the others to help on the Saturday-night load and carry the Sunday load on it while No. 3 was being washed and fired up again in time for the Monday-night load.

This process required the filling and firing up of two boilers each week, one of which was run but two days, so that its setting was cold each time it was fired. No boiler compound had been used and very little effort had been made to prevent further formation of scale, or to remove the old scale.

I immediately began using a boiler compound and set to work to remove the old scale from the boilers. A careful internal examination of the boilers was made and the assistant engineer was set to work getting off the scale from one of them. He spent an entire day at it and got off scale enough to show he had been at work, but it was hard work and a flue cleaner was purchased and by its aid about 500 pounds of scale was removed from each boiler.

After I had had charge of the plant about a month, boilers Nos. 1 and 2 would carry the load as easily as No. 3 had formerly, but as No. 3 received the same attention it was still the better boiler.

From this time on, the practice of firing up two cold boilers a week was discontinued and the fresh boiler that was cut in for the Saturday-night load carried it alone until the next Saturday night. This gave six days' time in which to cool, clean and repair No. 3 after each run, and as it was the most economical boiler it was used every other week, and a saving was made in several ways.

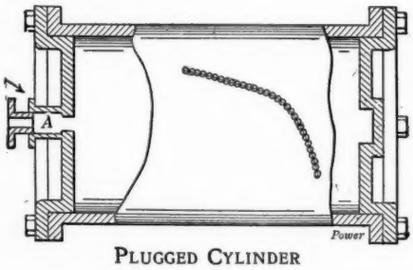
G. E. MILES.

Salida, Colo.

## Cylinder Troubles

At one time a cracked cylinder was repaired in the engine room without removing it from the engine frame.

An electric drill was used to drill holes through the crack, which holes were tapped and a copper plug dipped in iron cement screwed into each hole, as shown in the illustration. Then the job was gone over with a hammer and filed smooth both sides.




PLUGGED CYLINDER

An accident revealed a defect in an engine that had escaped detection for some years. The connecting rod was of the marine type, and one morning, when under light load, the heads flew off of the bolts, allowing the connecting rod to drop. It went through the floor, striking a joist on the outward stroke, and buckled the piston rod; on the return stroke the cylinder-head stuffing-box glands were also broken.

The stuffing box shown had not been bored out true with the cylinder, and one shoulder was nearly all on the bottom. There was a brass collar in the stuffing box that had been worn, there was no shoulder, and it had worked nearly into the cylinder.

We rigged up a device through the cylinder with a rod centered at the end of the cylinder and centered with the crank shaft at the other end, and secured a tool to the rod; then a crank was placed on the projecting end of the rod at the cylinder end and the stuffing box was rebored.

After finishing the repairs I noticed an occasional and peculiar knock in the engine which puzzled me for some months. I examined the stuffing box and found that the new throat collar that we had placed in it was a pretty loose fit, and when the piston was on the outward stroke the end packing contracted and the steam forced the collar against the packing. When the piston started on the return stroke the collar came back with a knock.

WILLIAM G. WALTERS.

Stratford, Canada.

## Valve Stem Broke

In the electric-light and power plant where I am employed as engineer, a boiler-feed pump failed to pump.

After going over the pump and testing the steam valves, I tried the gate valve on the discharge pipe and found it quite loose. Taking off the bonnet, I found the stem broken and the disks stuck on their seats. After removing the disks and replacing the bonnet the pump worked all right. It is these little things that, when found, help to simplify power-plant difficulties.

J. E. DAWSON.

Cumberland, Md.

## Put Shims under Knock-off Block

I have charge of an 18x36-inch Corliss engine, making 80 revolutions per minute, and the load varies from no load to 200 horsepower.

When the load was all thrown off, the governor would throw the knock-off cams so far back that the cam levers would strike the bolts that hold the springs on the steam hooks and that would cause the governor to jump and the engine to race.

To overcome this trouble I removed the knock-off blocks and cut out liners the size of the block from 1/16-inch sheet iron and drilled a hole in them for the screw and secured them under the blocks. I then readjusted the governor rods, and have had no trouble since. The governor works nicely, and the engine runs just the same with no load as with a full load.

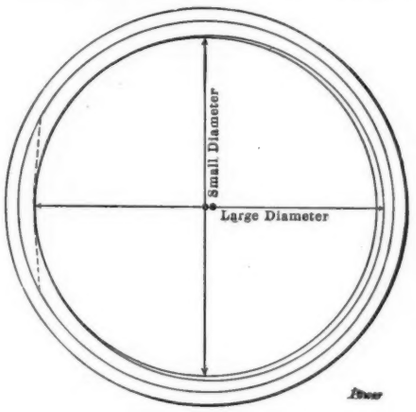
GEORGE H. LEE.

St. Louis, Mo.

## Truing a Crank Pin

The subject of flat and badly scored crank pins is of interest to most engineers. A crank pin cannot well be taken out and trued up in a lathe, and it, therefore, falls to the lot of the operating engineer to devise some means of remedying the trouble, and the file is usually called into service.

The first thing to know is what size the finished pin is to be. The calipers




TWO SIZES OF PIN

are put on the flat pin to find its smallest diameter, which will be the largest diameter of the trued-up pin. Most of the wear is found on one side of the pin and consequently if the pin is filed true in the manner suggested, the center of the pin will be changed, thus shortening the piston stroke a little. However, this would not be very noticeable, and in a pin 1/16 inch out the difference in the stroke could easily be taken care of. If the pin were filed all around and the same center retained, the pin would be smaller than it would be if filed, using the new center; see illustration.

A piece of wire should be filed to precisely the same length as the finished diameter of the pin. The crank-rod boxes should be rebabbitted and bored, using the wire as a gage. The boxes should be left as they come from the lathe without any scraping, as one-half of the box is to be used as a templet while filing the pin. A sharp bastard file will rasp off stock pretty fast, commencing at the heaviest part of the cut. One-half of the pin should be roughed down and practically finished before starting on the other side, often using the half box as a templet and filing down the high places until a good bearing is obtained. The pin must also be filed as square with the crank as possible. Red lead should be used in the templet to mark the high spots when filing and should be used quite sparingly as too much lead will not show a true bearing. The least possible amount applied with the finger to just mark the high places will be enough.

After both sides of the pin have been brought down to a fairly good finish and as round as possible, the pin should be polished with emery cloth held in a clamp, such as is used to polish shafting. This clamp is made of two pieces of 3-inch stock with a section bored out about the size of the pin, and a piece of leather tacked on for a hinge.

The boxes should then be scraped, oil grooves cut, put together and not keyed up too tight at first, until the pin has fitted itself to the box a little. Then key up until a proper adjustment has been obtained.

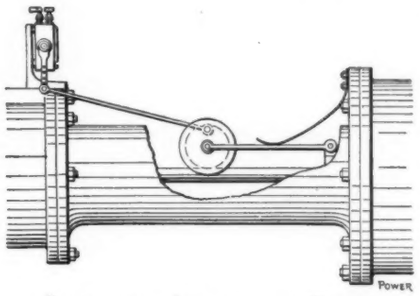
CHARLES H. TAYLOR.

Bridgeport, Conn.

## Attaching a Force Feed Lubricator to a Pump

A question was put to me recently in reference to attaching a positive feed lubricator to a pump of which the only exposed moving part is the piston rod, the distance between the stuffing boxes being such as to leave no part of the piston rod not passing through the stuffing boxes to which connection can be made to obtain motion for operating the oil pump.

One method would be to put a grooved roll on the top side of the rod, and keep



LUBRICATOR ATTACHED TO PUMP

the roller in contact with it by means of a spring, the motion for the lubricator to be derived from the roller. The accompanying sketch gives an idea of the plan I would suggest. The roller should be made of some material that will make a good frictional contact with the piston rod, and also withstand the heat.

GEORGE J. LITTLE.

Passaic, N. J.

## Cemented Cracked Pipe

A 30-inch cast-iron pipe was used as an intake from the river to the condenser-pump house. It was built in the form of a siphon, and a piece 12 feet long cracked about half way around at the junction of one end and the flange.

The surface was cleaned with muriatic acid, washed with water and dried. Then an iron cement was applied and allowed to stand four hours. Although the line has a 12-inch vacuum, it has since given no trouble.

E. H. LANE.

Kansas City, Mo.

## Measuring an Indicator Diagram

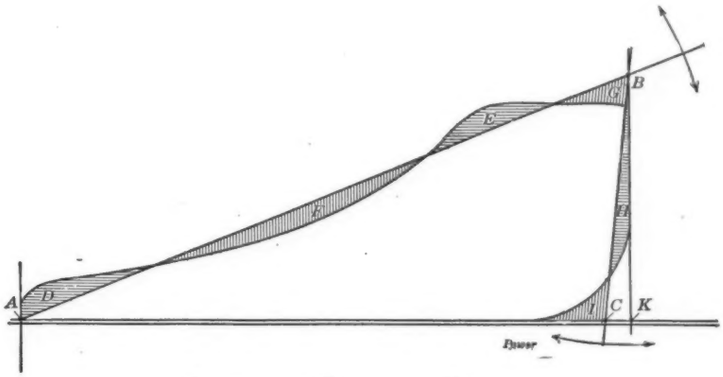
A fairly accurate method of measuring the area of indicator diagrams, when a planimeter is not at hand, is shown in the cut, and works out as follows:

Extend the exhaust line *AC*, and at the point *A*, which is the intersection of *AC* with a vertical line drawn through the end of the diagram, fasten a pin through the paper to hold one end of a thread.

The other end *B* is placed in such a position that the sum of the areas *D* and *E* is as near equal as possible to that of the areas *F* and *G*.

After this position has been obtained to the satisfaction of the eye, another pin is placed at the point *B*, the thread wound around it and the operation is again performed at *C* until the area of *H* is equal to the area of *C*.

In this manner the original diagram is supplanted by a triangle *ABC* of approximately the same area, which can be calculated by the following formula:




POSITION OF THREAD ON DIAGRAM

When *AC* equals the base and *BK* the altitude

$$Area = AC \times \frac{BK}{2}$$

After a little practice very close results may be obtained with this method, rough though it may seem.

RULOF KLEIN.

New York City.

# Questions Before the House

*Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues*

## Two Hundred Horsepower Horizontal Boilers

I notice in the issue of December 13 an inquirer wants to know if horizontal tubular boilers are made in sizes of 200 horsepower. I know of two plants equipped with boilers of this size, 78 inches in diameter by 20 feet long, and containing 2000 square feet of heating surface.

I have had charge of four units of the above dimensions since their installation six years ago. The shells are built of 17/32-inch sheets in three courses: have quadruple-riveted double-strap joints and are designed for 150 pounds pressure.

The repair bills on the four amounted to $18 in that time. This cost was for having the fire seams calked on the inside as they showed a slight disposition to leak at this point.

The only other defects that have shown up are three or four fire cracks at the fire seam. These have not been serious enough to need more than calking.

As regards economy, we are not fixed for making accurate evaporation tests but believe they will hold their own with the water-tube type.

Our only objection to them is the curvilinear seam over the fire. At this point we have $1\frac{1}{16}$ inches of metal between the fire and water which is too much even if the boiler is kept free from scale. There has never been the slightest tube leakage. We were told that 4-inch tubes 20 feet long would give us no end of trouble by sagging, but nothing of the kind has occurred. So far as repairs are concerned we feel that no type of boiler could show a much better record. They have had the best of care and the feed water has passed through a purifying process before entering the boilers.

From my point of view it is a most short-sighted policy for steam users to supply their boilers with water containing scale-making impurities when there are at least a dozen concerns making purifying apparatus that will remedy the trouble. Bad water in a boiler makes for poor economy in the use of fuel and high repair bills.

Some things that boilermakers do are hard for me to understand. One thing is, for instance, they put 6-inch steam outlet nozzles on a 200-horsepower boiler and the same size on a 150-horsepower. I suppose I am about the only engineer who ever put a steam-engine indicator on a steam drum or header. I was trying to find out if the pressure in the drum pulsated with the engine. Also, I had a slight suspicion that the pressure was greater in the boiler than in the drum.

J. O. BENEFIEL.

Anderson, Ind.

## Treatment of Subordinates

Several of the articles recently published in POWER bearing on the treatment of help in the power plant were very fine. I have always found that a man, perhaps by good fortune, promoted to a place of authority, who takes advantage of his position by being tyrannous with those under him, very soon gets up against trouble. An assistant can ward off lots of annoyances for the chief engineer and he will if treated right. When a man treats his subordinates considerately they take an interest in their work, if they are the right kind of men, and will be on the alert to keep things about the plant in the pink of condition. If they do not show a desire to do this with fair treatment, they should be discharged. One does not have to put on a "big air" or look over the tops of the men's heads in order to hold a place as "boss." Often, this seems to be necessary to those who occupy places which they are not fitted to fill. Sometimes a man has a subordinate who could fill his place just as well or better than he does. In such cases the man "higher up" is usually extremely jealous. I remember a remark that was made to me one time some years since by a man of this type. He said, "You should not tell those young fellows all you know, for they will soon know as much as you do." I did not tell him that that would not be much. I reasoned that while the young fellows were learning, I could be doing likewise. I think that one should always show as much consideration as possible to those who are seeking information, so long as they are men of the right character.

I believe in good men—they are just a bit scarce—a good set of men means a good organization which not only means success for the chief but success for the plant. I tell you, boys, your subordinates can do a lot toward your holding your job; the fact cannot be disputed. The man who wants to learn should always be shown as he may make a mark some day which will reflect no discredit to the one who started him off.

It is often remarked that some men cannot stand good treatment. This is true and when such a one is discovered it would be well to let him find another occupation; the engine room is no place for him—what I want is a man that I can reason with, and treat in the right way. A man that has to be driven is not the kind that goes to make up a good organization. I want help from the coal bunker to the switchboard that will take interest each in his particular part of the work.

C. R. MCGAHEY.

Baltimore, Md.

## The Double Entasis

In POWER for January 3, my attention was specially attracted to the chimney of the Queen Lane filter plant, that is, to the "pot-bellied" appearance of the shaft. There is nothing in mechanics, mathematics or beauty that justifies that shape, and it seems to me that the man who can make a thing that is dead wrong look better than one that is right, or nearer right, should have his taste cultivated. Mathematicians tell me that increasing the area to meet increased load would result in a concave, rather than a convex outline; anyway, the convex cannot be right. It is plain that the reason why chimneys are built larger at the bottom than the top is because there is more weight to be carried at the bottom than at the top, and the wind pressure must be withstood. It needs no figures to show that increasing the size above the bottom adds nothing but weight and wind-pressure area, neither of which is wanted.

I do not know but that the "swelled" columns are so common that people may have learned to believe that they look best. With a plain taper one, like the one mentioned, and one concaved like some of the Constantinople shafts, I am sure few, if any, would select the convex one as being the best looking.

JOHN E. SWEET.

Syracuse, N. Y.

## Chimney Problem

Referring to L. G. Watry's chimney problem in the December 27 issue, most of the hot gases will pass up the larger opening, and the chimney with the smaller opening will not be of much service.

The best thing to do is to divide the smoke box in half, which would make a separate stack for each boiler.

Another way would be to cut out stack No. 2 and build an addition to stack No. 1 and use this stack only, which is capable of producing enough draft for both boilers.

MIKE FUKER.

Chicago, Ill.

## Does the Crosshead Stop?

I have been much interested in reading the discussion of the question, "Does the Crosshead Stop?" I would like to ask a question. If the crosshead does not stop for its return trip, what becomes of it, or, in other words, where does it go?

If a person is running a race and has to return over the same ground, he must stop for the fraction of a second as he turns to retrace his steps.

E. M. COBURN.

St. Johnsburg, Vt.

## Boiler Efficiency of 82.36 per Cent

There is an error in the report of the boiler test in the issue of November 29, in which an efficiency of 82.36 per cent. is claimed, and if, as was stated, a bonus was "paid immediately after the completion of the official tests" on the basis of "$1000 for each per cent. efficiency above the contract requirements of 65 per cent.," or $17,360, then the Government paid several thousand dollars more than was justly due. It is well known that it is practically impossible to obtain from a water-tube boiler of the inclined-tube type, with an ordinary furnace, in which the tubes are directly above the fire, hand firing and soft coal, an efficiency above 76 or 77 per cent. Any higher figure indicates that an error was made either in the test or in the computation of the results. The errors that may occur in the test are the following:

1. Error in the calorimetric determination of the heat value of the fuel, giving too low a result.
2. "Stealing of coal" by the fireman.
3. Error in weighing the coal or the water.
4. Leaks of water from the boiler.
5. Error of judgment in estimating the quantity and condition of the fuel on the grate at the beginning and end of the test.

It does not appear from the record of the test that any of these errors were made. The heat value of the fuel per pound of combustible, 15,683 B.t.u., is within the range of what is found generally with Pocahontas coal, which runs usually between 15,600 and 15,900. The error in the figure given is not likely to be more than 1 per cent. There is also a possible error of 1 per cent. in the weight of water fed to the boiler, as it was weighed in tanks when very hot (the official record giving the temperature as 183.57 degrees), and must have lost some weight by evaporation from the surface of the three or four tanks and as it flowed from an upper tank to a lower one. These are only minor errors, but they may possibly account for $2000 of the bonus. The great error, however, is in the computation and it amounts to not less than 6.5 per cent., corresponding to $6500 bonus.

According to the record, the water evaporated under actual conditions per pound of coal as fired was 10.30 pounds. The weight of water fed was 129,218 pounds and the weight of the coal fired was 12,545 pounds. The coal contained 1.76 per cent. moisture, and the ash and refuse was 2.56 per cent. of the dry coal, making 12,006 pounds of combustible. The average feed-water temperature was 183.57 degrees, the steam pressure, 188.06 pounds, gage, and the superheat 98.79 degrees. Using the Marks-Davis steam tables, these figures give a factor of evaporation of 1.1391, which multiplied by 129,218 gives 147,192. The official report gives 157,312, a difference of 10,120 pounds, or 6.8 per cent. error. The economic results as reported and as corrected are as follows:

| Equivalent Evaporation from and at 212 Degrees. | Reported. | Corrected. |
|---|---|---|
| Per pound of coal as fired | 12.53 | 11.733 |
| Per pound of dry coal | 12.76 | 11.946 |
| Per pound of combustible | 13.10 | 12.260 |

The efficiency, corrected, is calculated as follows: The calorific value per pound of the dry coal, as reported in POWER, being 15,292 B.t.u., and that of the combustible 15,863.5 B.t.u., the efficiency of the boiler is,

$$12.260 \times 970.4 \div 15{,}683.5 = 75.86$$

*per cent.*

The efficiency of the boiler, including the grate is,

$$11.946 \times 970.4 \div 15{,}292 = 75.81$$

*per cent.*

The reported efficiency, 82.36 per cent., is 6.55 greater than this, showing an error of

$$6.55 \div 75.81 = 8.6 \text{ } \textit{per cent.},$$

as compared with 6.8 per cent. error in the equivalent evaporation from and at 212 degrees.

The capacity developed in the test is

$$147{,}192 \div (8 \times 34.5) = 533.3$$

*horsepower*

instead of 570 horsepower as reported, and the water evaporated from and at 212 degrees per square foot of heating surface,

$147{,}192 \div (8 \times 4079) = 4.51$ *pounds*

instead of 4.82 as reported.

In all cases where a very high efficiency is reported as the result of a boiler test it is well to check the figures by making an approximate heat balance.

We have not sufficient data for a complete balance, but an approximate one may be made from the following:

Heating value per pound combustible, 15,683 B.t.u.
Probable analysis of the combustible, 91C, 5H, 4(O + N + S).
Air per pound combustible for maximum economy, say, 21 pounds.
Dry gas per pound combustible for maximum economy, say, 22 pounds.
Specific heat of gas, 0.24.
Temperature of flue gases, 474 degrees; of fire room, 90 degrees.
Specific heat of water vapor, 0.46.
Moisture in coal, referred to combustible, 1.86 per cent.
Moisture in air at 90 degrees, assuming 90 per cent. saturation, 0.027 pound.

| | | |
|---|---|---|
| Heat absorbed by the boiler per pound combustible, corrected figures, $12.26 \times 970.4 =$ | 11,897 B.t.u. = | 75.86 per cent. |
| Heat lost in the dry gases, $22 \times (474 - 90) \times 0.24 =$ | 2,028 B.t.u. = | 12.93 per cent. |
| Loss due to moisture in coal, $0.0186 \times (612 - 90) + 970 + (474 - 212) \times 0.46 =$ | 23 B.t.u. = | 0.15 per cent. |
| Loss due to moisture in air, $21 \times 0.027 \times (474 - 90) \times 0.046 =$ | 100 B.t.u. = | 0.64 per cent. |
| Loss due to moisture formed by burning hydrogen of the coal, $0.05 \times 9 \times [(212 - 90) + 970 + (474 - 212)] =$ | 546 B.t.u. = | 3.48 per cent. |
| | 14,594 B.t.u. = | 93.06 per cent. |
| Loss due to radiation, to C burned to CO, to unburned hydrocarbons and to fuel lost through the gates | 1,089 B.t.u. = | 6.95 per cent. |
| Total | 15,683 B.t.u. = | 100.00 per cent. |

The corrected efficiency, based on the combustible, of 75.86 per cent., is a very satisfactory and creditable result, but it is not more than might be expected from such a boiler with Pocahontas coal, when the "high percentage of $CO_2$ (12.46 per cent.) was obtained by close supervision of the draft." The figure indicates not only that the setting was in good condition, but that the firing was good.

It is difficult to understand why a bonus was offered for each per cent. of efficiency above 65 per cent. This figure would be an exceedingly low result for any good type of boiler using Pocahontas coal, not overdriven, and with expert firing. The difference between 65 and 75 per cent. means a bonus of $10,000. Why should the Government offer to pay such a large bonus for a performance that is no higher than might reasonably be expected? Why should a bonus ever be paid on the performance of a standard apparatus, such as a water-tube boiler with an ordinary grate, when the dimensions, heating and grate surface, etc., are all specified in the contract? Unless the price of the boiler without the bonus was lower than the ordinary or normal price it appears that the Government is "out" the whole amount of the bonus, $6500 on account

of an error in computation of the results of the test, and nearly $11,000 on account of an error of judgment in drawing the specifications and contract.

WILLIAM KENT.

New York City.

## Automatic Nonreturn Valves

I noticed an inquiry from Louis J. Corilla in the December 20 issue in regard to "Automatic Nonreturn Valves."

For the past three years I have had charge of forty 10-inch and ten 4-inch valves of this type and have never noticed a failure to close. Several times in this time one has failed to open, but the trouble is always due to a gummy deposit on the plunger of the valve, which can easily be cleaned off by simply removing the valve bonnet and using cool oil and fine sand paper. They do not chatter, neither do they wire draw the steam. As for their value, I simply state that there should be a law making their use compulsory in plants of any size. We have had several tubes blow out, but we did not know anything about it in the engine room until it was all over. In one plant of four water-tube boilers I was shut down once by a feed pipe breaking off at the drum where we had no nonreturn valve. I also know of a 5000-kilowatt plant being completely shut down two times for the want of these valves. The only thing to guard against is this gum on the plungers, and two hours per year per valve will take care of this.

E. H. LANE.

Kansas City, Mo.

## Accumulators for Furnace and Boiler Capacity

In the editorial, "Accumulators for Furnace and Boiler Capacity," in the November 29 issue, we read the following:

"It has been one of the first precepts of a boiler room to keep the pressure constant, but it is a question if the boiler pressure cannot be allowed to vary through a considerable range with less damage to the over-all efficiency than would result from the constant manipulation of the damper and the slice bar necessary to hold it constant. At the pressure ordinarily carried, a considerable pressure drop will produce a comparatively insignificant change in the initial temperature, and it is the temperature range which affects the efficiency!"

For one, I am sorry that the writer of the paragraph just quoted did not go a little more into detail relative to constant boiler pressure and its attending advantages or disadvantages as the case may be; therefore, I am in hopes that this writing may bring out some more points along this line.

In the first place, just what are we to understand by "the over-all efficiency"? Second, what would be the allowable variation in boiler pressure? Third, if a considerable variation is permissible, it seems to me the allowable range would be governed somewhat by the nature of the steam in use; that is, saturated or superheated.

The temperature of saturated steam at 130 pounds gage, 145 pounds absolute, is 355 degrees and the total heat in the steam above 32 degrees is 1190 heat units. With a gage pressure of 115 pounds, 130 pounds absolute, the temperature is 347 degrees, and the total heat in the steam above 32 degrees is 1187 heat units. We note by these figures that with a drop of 15 pounds pressure there is a drop of only 8 degrees in the temperature of the steam and a loss of only 3 heat units. Now, if in these two cases the steam is flowing through a superheater and is getting 100 degrees of superheat in the first instance, it seems to me that in the second case the cooler steam—even though a large number of pounds may be passing in a given time—will take up sufficient additional heat units, not only because the temperature of the steam is lower but also because the temperature of the hot gases circulating is increased, due to the stronger draft made necessary by the increased demand for steam, to make the final temperature of the steam the same in both cases. If these statements are correct, it would seem that a variation of at least 15 pounds in the steam pressure would not affect the final results when superheated steam is used.

It would seem, too, that with saturated steam and a variation of only 8 degrees, the economy would be affected but little, if any; yet, my experience is not in accord with the theory stated, as the following will show:

In a certain power plant, running 16 hours per day, two firemen were employed, working eight hours each; one would carry the steam pressure at or near 110 pounds throughout the entire eight hours, with but little need for the use of the slice bar, the damper being handled by a regulator. The other man, working his shift under precisely the same operating conditions as to load, length of time, etc., would have the steam pressure anywhere from 90 to 110 pounds, would use the slice bar much more than the other man did and burned 500 pounds of coal more; and it made no difference which shift this man worked, the results were the same.

Now, while looking into the matter a little further and from another viewpoint, we will grant the statement, as probably correct, that the "over-all efficiency is not affected by a considerable variation in the range of boiler pressure!" However, it seems to me that there are other conditions, aside from the effect on the efficiency, produced by permitting a considerable variation in the range of the boiler pressure, which are not favorable to continuity of service and which should make it desirable to carry the pressure as nearly uniform as possible. Of course, the intervals of these variations will determine somewhat the deleterious effects produced.

It is well known that with every change in steam pressure there is a corresponding change in the contour of the boiler, the effect being more marked in the lap-seam boiler than in the butt-joint type, with detrimental results in the latter case as well as the former. Then, too, with the fluctuation in the steam pressure, there must be a variable furnace temperature, with more rapid deterioration of furnace walls and boiler, due to excessive contraction and expansion, than would be otherwise if the temperature were more uniform.

I am well aware that it would be a hard matter to determine the effects produced by some of the conditions mentioned above; however, I am desirous of bringing out the ideas of others along this line, for I believe it will be beneficial to those of us who, as yet, have a great deal to learn.

A. K. VRADENBURGH.

Albany, N. Y.

## Handling Men

I was interested in J. M. Row's letter on the above subject which appeared in a recent issue. It contains some sound general advice, and, if followed, no doubt it would result in financial benefit to both employer and employee. I wish to say here a few words about the different systems of handling help, and, as fairly as I can, compare the results obtained. The three plants discussed are each of about 5000 kilowatts capacity.

The first is a plant, one of a chain, supplying power for street-railway service. It is in charge of a chief engineer who has under him three assistants, three oilers, five firemen, four cleaners and coal passers and one repairman and his helper. The salary of the chief is fair, but that of the rest is low. The main duty of the assistant is to watch the switchboard, keeping the voltage steady, throwing in the circuit breakers when they come out, and reading the wattmeter and to note the temperature of the feed water hourly. He does no repair work and must not be absent from the switchboard even to start an extra engine, which is done by the oiler. In fact, his work is simply that of a switchboard tender, a job which could be very satisfactorily filled by a bright fireman. Yet the assistant engineer must hold a first-class engineer's license. The repair work is looked after by a repairman of steamfitting experience only, under the direct

supervision of the chief. His hours correspond to those of the chief's, except that he is subject to calls at all hours of the night. As these, however, are extra time for him, naturally, he is called to attend to those things only which are absolutely necessary to keep the plant running.

The condition of the plant as to orderliness and cleanliness is above reproach, and the casual visitor would readily believe that this is a model plant. The steam pipes from the boilers to the engines and their auxiliaries, however, pass through a basement tunnel, which cannot be seen from the engine-room floor, and, indeed, its dimensions are barely discernible even when fronting it in the basement; but its presence is positively made known by the large number of steam leaks. It stands to reason that one ill-paid repairman and a helper, plus the chief engineer, who, of course, cannot be expected to do more than supervise the work done, cannot possibly maintain a station of this size in sound condition. Consequently, the whole equipment from the governors of the engines to the blow-off valves suffers. Yet no man can point to anything that is very much out of repair. It is, no doubt, needless to say that it is not one single piece of apparatus in a large plant that is the cause of low economy, but the combined total of a lot of little things, each of which may be only a little bit out. And here are the figures to prove this in the case of this station:

Average number of pounds of coal consumed per kilowatt per hour, 3.6; labor per kilowatt per hour, 0.11 cent; cost of fuel and labor per kilowatt per hour, 0.6752 cent.

Yet this station has all the help necessary to maintain it in first-class condition, if the system of managing the help was changed only slightly, as is proved by the next case.

This plant is another street-railway power station, of about like equipment and capacity. It is operated by a chief engineer and two assistants, four oilers, eight firemen and five coal passers. Out of this gang, ordinarily, there are available for repairs and cleaning up, about five men. The chief engineer's wage is fair; that of the rest of the men is good. When the assistant engineer comes on his watch he finds written on a sheet of paper a list of the repair work necessary to be done that day. All the spare help report to him, and it is his duty to divide the work among them according to their abilities. He sees that all do their portion properly, and that each uses the required stock to the best advantage and without waste. It is surprising the amount of repair work that can be done in a few hours by the men, who soon become highly trained. Jobs that 90 per cent. of other power houses would send for outside help to do, are here thought very little of. Of course, they have all the necessary tools, such as drill, lathe, shaper, etc., to do their work with. The result is highly efficient apparatus, but not a very good-looking plant. By the latter is meant that the visitor will find the paint scratched off nuts and the surrounding metal, and, here and there, a chunk of asbestos covering off some of the steam lines. But he will find no leaks, either steam or water, nor will he see any clattering apparatus, which has to hustle to make good. The log-book figures for this station are as follows:

Pounds of coal per kilowatt per hour, 2.5; labor per kilowatt per hour, 0.16 cent; cost of coal and labor per kilowatt per hour, 0.552 cent. The coal costs 20 cents per ton more at this station than at the other.

Taking all of the figures, such as cost of repairs, etc., this station delivers the same amount of work as that in the first case, at a saving of $175 per week.

The next case is that of an electric-light station which is seven years older than the two samples considered above, but outstrips both in economy of operation. It is presided over by a chief engineer who, after giving much intelligent thought to the handling of his help, developed a system which, in my estimation, is nearly perfect. It is never essential for him to ask, "Who did this, or who did that job?" And none can evade responsibility by stringing that oft repeated excuse, "The other fellow don't do it." He has all of the men in competition with one another, and he has a method of rewarding those who try to do their best, without showing favoritism to any.

To describe the system fully in this letter would take too long, and to attempt to describe it briefly would not do it justice. Suffice it to say now, that his method is somewhat similar to that used in the second case; but, in addition, every man has a certain task for which he is held responsible. For instance, one assistant engineer is responsible for the general good behavior of one engine; he must see that the boxes are properly keyed up, all lost motion in the valve gears taken up, etc. Again, one oiler, though he must look after and keep clean all running apparatus, is responsible for the bright work on one engine only. It will easily be understood that one assistant tries to keep his engine running as well as, or better than, the other's engine, and that one oiler tries to outshine the other. This competitive system, carried from assistant engineer to coal passer and directed by a tactful chief, who knows how to maintain it, works wonders, as the following figures prove:

Pounds of coal per kilowatt per hour, 2.34; labor per kilowatt per hour, 0.13 cent; cost for coal and labor per kilowatt per hour, 0.5319 cent.

WILLIAM POWELL.

Ashland, Mass.

## The Chief and His Subordinates

There often seems to be a feeling of resentment on the part of the chief when he is approached by an assistant who is striving to rise to a higher plane in his chosen profession. During my short career as an engineer, I have found but one chief who was willing to explain things in detail.

I well remember an experience with one of those men who do not have time to listen to the operating engineer's suggestions.

The plant consisted of one 150- and two 100-horsepower tubular boilers, carrying steam at 120 pounds gage pressure; one 18x42-inch Corliss engine; one 100-kilowatt alternating-current and one 2000-volt direct-current series arc machine, belted to a line shaft.

I found the flues half full of soot and after a little talk with the fireman was able to get him busy with the flue cleaner. Then, I rigged up a device for blowing the flues and had them blown morning, noon and night. When the fireman found that I was working for his interests, conditions began to improve, insofar as our end of the plant was concerned.

The chief never found fault with me at any time, for if he had I would have looked for another job right away. I am always willing to listen and want to learn all that I can, and it is the hight of my ambition to be a chief and if ever I attain that position, I will spare no effort to be worthy of the trust placed in me.

M. V. MILLER.

Fort Snelling, Minn.

## Blowoff Piping

In the issue of POWER for December 20, I noticed a letter by Edward Hamilton describing the blowoff arrangement in his boiler plant. That this arrangement is a satisfactory one is due to the manner in which the blowoff pipes are protected from the heat, and to that only, as a little consideration will show that his so called circulation pipe in no way affects the result. If the connection is made as shown in the sketch that accompanied his letter, that is, into the steam space of the boiler, all the circulation that such an arrangement would give would be that due to the condensation of the steam in the small riser, which would be of no practical value.

Had this pipe been made the full size of the blowoff connection and then carried into the boiler above the first row of tubes and below the water line, the results would be different.

O. B. CRITCHLOW.

Woodlawn, Penn.

## A Method for Getting High $CO_2$

Orosco C. Woolson sends in the following belated discussion of the paper upon "Combustion and Boiler Efficiency," presented to the recent meeting of the American Society of Mechanical Engineers, by Edward A. Uehling.

To secure practical benefit from any $CO_2$ recorder it is necessary not only to have the apparatus properly installed, but to have its readings correctly interpreted, taking into account potent conditions which might exist, abnormal or otherwise, and which would prove a puzzle to many, and even to an expert should he be lacking in a keen appreciation of such conditions.

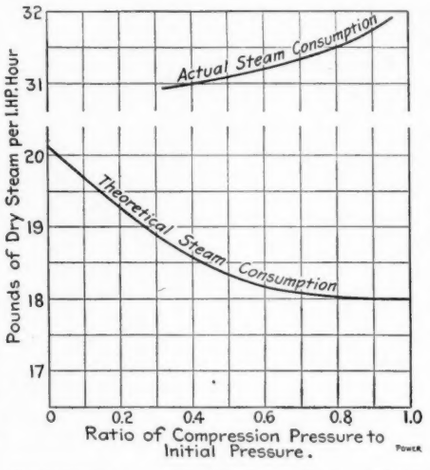
To get at the business end of the question so that results shall show on the right side of the ledger is, in my estimation, a difficult thing to accomplish, and unless some other explanation can be offered for so many $CO_2$ recorders being out of business in different power houses, I am forced to the conclusion that we are attempting to establish a too refined apparatus for determining what is required to obtain the greatest value from our boiler plants except for expert testing.

I have an invention of my own which I have tried for some years to put into everyday practice. I have secured no patent on it, yet I will magnanimously permit any member in good standing in the society to appropriate it, to wit:

Say to your chief engineer, "Bill! the longer I live the more I find, by gracious, out and I find, by gracious, that it's time to raise your salary and I am only astonished that I did not find this out before, but don't think, Bill, this is philanthrophy on my part. I am going to make a $CO_2$ recorder out of you at about $300 per year, but I want you to save me $600 a year in fuel by devoting more of your time to the boiler room. Your assistants are quite capable of watching those automatic cutoff and turbine engines with their fine adjustments go around, but you know as well as I do that the fire room is lacking that careful and intelligent adjustment which it should have to secure the highest degree of 'actinism' possible, and, Bill, if you don't get on to that word, actinism, just look it up, for it's part of my $CO_2$ invention, and I want you to study up and produce for me the greatest actinic value that bituminous coal can accomplish. And, by the way, let me say this to you, don't let me catch you in the fire room with your coat off doing the work I am paying others to do, but you just use your brains that I pay for and notice whether the firemen, or, more properly speaking, the furnace tenders, keep their fire doors closed continuously or whether they are up to the same old trick of their youth of jerking the fire door open every time they walk up to the boiler. You have noticed, Bill, that that fire door is provided with a large peep hole that will admit of surveying the interior of the furnace all right, and, inasmuch as I paid for that hole, I want you to get the money's worth out of it; otherwise my $CO_2$ invention will record a minus mark against you. Now, Bill, you get busy and do as I suggest and the extra salary is yours at the end of the year and I shall be saving money myself. One thing more, Bill, if you find after careful investigation you think it would be better, all around, to build a trestle alongside of our boiler house sufficiently high to admit of spouting the coal direct into the magazines of those furnaces instead of dropping the coal clear down to the fire-room floor, for the sake of lifting it up again to feed the furnaces, just let me know, and we will see if we can't accomplish still further good results; but, as I remarked before, you get busy on the boiler room and you will find that what Mr. Uehling says is beginning to be recognized as essential for good results, is true."

## Compression in the Steam Engine

The *Sibley Journal* for December contains a contribution by Prof. R. C. Carpenter upon the subject of "Compression in the Steam Engine." The article is in the nature of a review of what has been done to settle this controversial question and contains the results of a test conducted by the author several years ago upon the high-pressure cylinder of a triple-expansion Corliss engine at the Sibley College experimental laboratories.




THEORETICAL AND ACTUAL STEAM CONSUMPTION

Three sets of runs were made at a vacuum of about six inches with constant pressure at the throttle, constant cutoff and varying compression, the degrees of compression being 42.8, 66.3 and 87.2 per cent. of the admission pressure. The steam consumptions on these runs were respectively 31.03, 31.3 and 31.7 pounds per indicated horsepower-hour. The increase in the water rate with increased consumption is here so slight as to have very little effect upon the economy of the engine, but, nevertheless, it is opposite to what a theoretical treatment of the subject would indicate.

The accompanying chart shows the actual steam consumption as plotted from the tests and the theoretical steam consumption of the engine working without cylinder condensation. The slopes of these curves are opposite, although the theoretical curve shows a very slight improvement in economy after the ratio of compression to initial pressures passes 60 per cent. The discrepancy is undoubtedly due to losses the exact nature of which is not well understood and, as Professor Carpenter remarks, "It is evident that further investigation is necessary to find out what is the matter with our theory."

It is proposed to make further investigations along this line in the laboratories of Sibley College with a view to throwing light upon the discrepancy between the predicted and the actual results, which information should go far toward settling the controversy which is now being waged between the adherents and the foes of compression.

In the annual report of *Lloyd's Register*, recently issued, reference is made to the use of internal-combustion engines for marine purposes. With this type of engine there is considerable difficulty in effecting the reversal of the direction of rotation of the engine, and when these engines are used for marine purposes the astern motion of the screw has usually been obtained by the use of toothed-wheel gearing. Comparatively recently there has been a development in the Diesel oil engine for marine work. A two-stroke cycle has been successfully adopted, and the reversal is effected in the engine itself, the crank shaft being directly coupled to the screw shaft. The Diesel oil engine is now being fitted to three fairly large vessels being built on the Continent under the supervision of the surveyors of *Lloyd's Register*. One set is being constructed on the older principle of the four-stroke cycle with single-acting cylinders, and will be of about 450 indicated horsepower. Another set is being made on the two-stroke cycle, also single acting, and is intended for a twin-screw vessel, the power being about 900 indicated horsepower on each shaft. The third set is being made on the two-stroke cycle double-acting system, each cylinder providing two impulses per revolution; this also will be fitted in a twin-screw vessel, the total power being about 1800 indicated horsepower. In each of these cases the engines will be directly coupled to the screw shafts. A set of internal-combustion engines is being constructed under the society's survey in this country for a vessel of about 260 tons.

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# POWER

## Notice!

The publishers of the paper called *Steam* have written us protesting against the statement on the first page of the year that POWER was made up of a lot of papers, including one called *Steam*, and asking us to place the matter right before our readers, which we are glad to do here and now.

POWER bought its rival, named *Steam*, a long time ago and carried the name as part of its own title for more than eight years.

The new paper calling itself *Steam* took that title—which it had a legal right to do—but this cannot prevent us from truthfully making the statement we did.

Certainly we can hardly be expected to apologize because our esteemed contemporary used a second-hand name that we had dropped.

## Conservation of New York State Water Powers

The recent proposal of Governor Dix to abolish the New York State Water Supply Commission and the renewed activity on the part of the New York Board of Trade toward the flooding of a portion of the State forest preserve again bring to the front the important question of conserving the water powers of the State. According to official reports the water power now in use in New York State, excluding the Niagara and the St. Lawrence rivers, which are international streams, amounts to six hundred and twenty thousand horsepower, while the surveys show that there is eight hundred and eighty thousand horsepower still undeveloped. The principal reason for over half the total available water power of the State being undeveloped is the uneven stream flows; many streams which overflow their banks and waste millions of gallons into the sea every spring, shrink to mere rivulets during the dry summer months. Therefore, plants located on such streams would require auxiliary steam equipments having a capacity nearly equal to the maximum power demand.

In 1907 the Water Supply Commission was created, and after three years of careful investigation submitted plans and recommendations for the construction of four great storage reservoirs to be located respectively on the Genesee, Sacandaga, Raquette and upper Hudson rivers, in addition to several smaller ones. By means of these reservoirs the stream flows could be regulated, resulting in a reduction of the great pecuniary damages caused by the periodic recurrence of floods and affording a constant flow for power purposes. It was proposed that the State issue bonds to the extent of twenty million dollars for the construction of these reservoirs and that they should be entirely under State control, the use of the water being leased for terms of fifty years to consumers at nominal charges which would be sufficient to produce a revenue to the State. A bill to this effect was introduced in the legislature but powerful influences were exerted to bring about its defeat. The power users were willing to pay an assessment sufficient to meet, in fifty years, the interest and sinking-fund charges on the bonds, but they insisted upon the right to use the water without charge and in perpetuity after the State had been reimbursed for its outlay.

Later the power users induced the legislature to pass a bill granting their demands through an amendment of the "River Improvement Act" but Governor Hughes vetoed it. The next step in this direction was an amendment to the constitution, introduced by Assemblyman Merritt, which provided for the flooding and the construction of storage reservoirs in the forest preserve, but this was worded so as to ignore any revenue to the State from the power development. This amendment must be approved by another legislature and then submitted to popular vote before it can become effective, but it is hoped that its shortcomings will have been recognized before that time arrives.

A comprehensive development of the available water powers would, undoubtedly, be a great boom to the manufacturing industries in western and northern New York. At the same time, the interests of the people at large make it imperative that such developments must be entirely under State control and produce a direct revenue besides. This is especially important in view of the fact that water-power privileges, amounting to two hundred thousand horsepower at Niagara Falls alone, were given away to private individuals before the State awoke to the necessity of changing its policy. One of the strongest arguments in favor of State control is that it would place the water at the disposal of anyone will-

ing to pay for it, and thus guard against monopolistic control, provided the *proper form of contract* and impartial administration are applied.

While it is conceded that the best interests of the State demand the adoption of a policy as herein outlined, the extent to which actual construction should be carried on at present demands careful consideration. Certain groups of individuals are advocating its immediate application to all the undeveloped water powers of the State; this would include the clearing and flooding of several hundred thousand acres of State forest lands. Yet there is no guarantee that a large part of the power thus made available would be used in the near future, and the people of the State would be carrying the burden of expense until such time as the utilization of all the power would make the investment self-supporting. This phase of the subject is important in view of the fact that New York City would bear nearly three-fourths of the expense and would be only remotely benefited by the results. Therefore, it is expedient that for the present, storage reservoirs be built only where there are prospects for the immediate sale of the power produced.

## The Proof of the Pudding

Suppose you were the owner or manager of a mill and upon the recommendation of your master mechanic had put a device upon your boilers which produced a large saving in coal. If tests made and reported by the master mechanic were criticized as nonsensical and impossible, if engineers and physicists proved by figures that no such results were attainable and scientists demonstrated scientifically the fallacy of the principle upon which it were based—but if your coal bills were less week after week and month after month, what would you say?

You would be apt to say that "The proof of the pudding is in the eating" and to give the inventor or the vendor of the device an enthusiastic letter of recommendation.

And it is by such a process as this that the enthusiastic and sincere indorsements which inventors and vendors of devices which contravene all the laws of physics and the principles of mechanics are obtained.

In a big New England mill, some of the boilers were equipped with a device which was supposed to decompose steam by the heat of the furnace and to add its hydrogen to the available fuel. The master mechanic tested it and reported an evaporation of over sixteen pounds of water with a pound of combustible. Engineers denied the possibility of any such a performance. Those who knew demonstrated that it cost more than it was worth to produce the hydrogen, but the treasurer said, "Here are the only figures that interest me," produced his diminished coal bills and ordered more of the devices.

What are the facts?

Here was a battery of fifteen 175-horsepower boilers, aggregating 2625 horsepower, connected to a six-foot chimney one hundred and seventy-five feet high, good, by any formula ordinarily used, for only about half that capacity. These boilers are mulling along with an insufficient air supply, doing only sixty-odd per cent. of their rated capacity, with the furnaces piled full of coal and producing gas to be sent off unburned up the chimney. This device with its steam jets is put on, the master mechanic, after "lots of trouble," gets his firemen trained to fire as directed, and behold—the diminished coal bills.

Of course, the boilers are not evaporating anything like 16.69 pounds of water per pound of coal. The master mechanic is evidently not a trained testing engineer and has fooled himself. Of course, the decomposed steam, if it really is decomposed, is of no net value as fuel.

The diminished coal bills do not establish a contravention of well known natural laws nor prove the value of a device based upon an evident fallacy. They simply do prove that the efficiency of the boiler plant has been improved and that could have been done by any change which secured an adequate draft and the same amount of drilling of the firemen, and at a cost considerably less than ten dollars per horsepower.

## Smoke and $CO_2$ Recorders

If the smoke which comes out of a smokestack were only as heavy as it is black, and would fall down in chunks on the head of the fireman who made it, firemen would lose no time in inventing some kind of device to warn them when such an eruption was about to occur.

We have steam gages on our boilers so we may not get the pressure too high and do us an injury. We have water glasses to warn us not to get the water too low, and now we want some simple apparatus to determine the percentage of $CO_2$ in the products of combustion and to determine their temperature so that we may be warned against the production of black smoke. Of course, we have the $CO_2$ meter and the pyrometer at the present time, but the cost, the delicacy and the unfamiliarity of the ordinary operator with either the instrument or the deduction of applicable knowledge from its indications have hindered the wide use of such apparatus, especially in small plants. Still, the day may come when the fireman will look to his $CO_2$ gage and his pyrometer as confidently and intelligently as he does now to his water glass and steam gage.

In a recent test of great importance, because it was to determine the suitability of a certain boiler for use in battleships of the United States Navy, Lieutenant Commander Dinger, one of the board of naval officers in charge of the test, in referring to the use of the $CO_2$ meter, said:

"The fireman soon became very much interested in the results of the gas analysis, and realized the value of so firing as to maintain as high a percentage of $CO_2$ as possible. This interest manifested itself very early in the tests, in the decreased density of the smoke escaping from the stack."

The foregoing remark in regard to the decreased density of smoke is of particular interest at the present time while cities all over the country are laboring to prevent smoke by the use of ordinances.

---

Compression as a corrective of clearance losses is gradually losing its hold. Prof. R. C. Carpenter in an article on "Compression" in *The Sibley Journal* says: "I have reached the conclusion that the loss of work caused by compression may in practice offset the gains which would otherwise be produced. The reason why the practical engine shows no improvement in economy with increase of compression is not clearly known. There is need for investigation and research of a high order before general laws or conclusions can be stated."

He quotes Professor Jacobus who, in a paper presented to the American Society of Mechanical Engineers, said: "The experiments prove that for either equal amounts of work produced or for equal points of cutoff the cushion steam in an engine should not in general be compressed as high as the initial pressure in order to obtain the best economy, but to some lower pressure, thus verifying conclusions arrived at by theory."

---

According to the official estimates of the Department of the Interior, the available water power in Canada is capable of developing more than twenty-five million horsepower annually; which, if produced from coal, would represent a consumption of approximately five hundred and fifty million tons per annum. This is excellent data for those individuals who are looking forward with so much apprehension to the time when the coal supply shall have been exhausted.

---

The pioneers of the air are sacrificing their lives freely in the cause of future navigation in the ocean of space, says the daily press. That is no reason, however, why an engineer should screw down the safety valves on his boiler to keep it from blowing off steam.

---

It is better that an engineer should know all about a safety valve than enough about hyperbolic logarithms to get by the examiner.

# Inquiries of General Interest

*Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it*

## *Lap Crack*

What is a lap crack in a boiler?

P. C. V.

It is a crack in that part of the sheet that laps over the other and extends along near the line of rivets.

## *Braces in Heine Boiler*

Has the Heine boiler any braces and, if so, where?

B. H. B.

There are braces extending across the opening from the drum into the water legs and the flat surfaces of the water legs are supported by staybolts.

## *Mud Drum Nipples*

If the nipples between the headers and the mud drum of a water-tube boiler are renewed and leak after repeated rolling, what can be done to stop the leaking?

M. D. N.

Get a mechanic who knows how to do tube expanding intelligently.

## *Advantage of Butt and Strap Joints*

If a double-riveted lap seam has an efficiency of 75 per cent. and a double-strap and butt joint has the same strength, what is the advantage of the butt joint over the other?

B. S. J.

In the boiler with a lap seam the shell is never round, and as the pressure tends to make it round the sheet bends near the lap, and the repeated bending which takes place at every change of pressure, however slight, finally cracks the sheet. In the boiler with the butt joint the shell may be made round at the start and no change of pressure will alter its shape and start a crack. It is believed that no boiler having a double-strap butt joint has ever exploded.

## *Pump Compression Valve*

If the compression valve on a duplex pump is closed, what effect does it have?

D. C. V.

The compression valve controls a passage between the steam and the exhaust port in the cylinder and when closed prevents steam from flowing from the steam port to the exhaust through this passage after the piston has covered the exhaust port. Thus considerable steam is trapped in the cylinder and compressed, shortening the stroke of the piston.

## *Factor of Safety and Water Pressure*

If, with a factor of safety of 5, a boiler has a working pressure of 150 pounds, how much cold-water pressure will it stand?

S. W. P.

With a factor of safety of 5, the calculated strength of the boiler would be 750 pounds, and the effect of internal pressure would be the same whether produced by steam or water. If tested by hydrostatic pressure, it would be carried to 50 per cent. above the working pressure, or, in this case, to 225 pounds.

## *Hunting of Engine Governor*

What is the probable cause of "hunting" by a Corliss engine governor?

H. E. G.

Undue friction between the moving parts; too heavy oil in the dashpot, or oil on the belt, making it slip.

## *Position of Eccentrics*

With two eccentrics on a Corliss engine, the steam eccentric moving in the direction of rotation to open the valve and the exhaust eccentric in the opposite direction to open the exhaust valves, what will be their relative positions on the shaft?

P. O. E.

Both eccentrics must rotate in the same direction with the shaft. If the steam eccentric is directly connected, it must be set 90 degrees plus the angular movement necessary to overcome the effects of the lap and lead of the valves ahead of the crank in the direction of rotation. If the exhaust eccentric is indirectly connected to the valves, it must be set 90 degrees minus the lap and lead of the valves behind the crank.

## *Pounding in Low-Pressure Cylinder*

In starting up a cross-compound Corliss engine there is a pound in the low-pressure cylinder which seems to be all over the cylinder. But when it is up to speed with the load on, it runs quietly. The same thing happens in shutting down after the load is thrown off. What causes the pound?

P. L. C.

It is probably caused by too high compression. When starting, the receiver pressure is low and the excessive compression in the cylinder forces the inlet valves from their seats and at the end of the stroke they fall into position with a bang. When the receiver pressure rises it holds the valves to their seats during compression and the engine is quiet.

## *Lap of Steam Valve*

What is lap in a slide valve, and what is the object in giving lap?

L. S. V.

Lap is the distance the edge of the valve extends or laps over the port when it is in the middle of its travel. Lap is given for the purpose of cutting off the flow of steam to the cylinder before the stroke of the piston is completed, thus using steam a part of the stroke expansively.

## *Pressure in Water Main*

If a standpipe 80 feet high is full of water, what will be the pressure in the main?

P. W. M.

A column of water one foot high will exert a pressure of 0.433 pound at the bottom. If the top of the water in the standpipe is 80 feet above the pressure gage, it will show a pressure of

$$0.433 \times 80 = 34.64 \text{ pounds.}$$

## *Reciprocal of 3.1416*

In getting the circumference of a circle I saw a man divide the diameter by a number instead of multiplying. What was this number and how did he get it?

R. O. P.

He used the reciprocal of 3.1416; that is, he divided 1 by 3.1416 and obtained 0.3183, which he used as a divisor. Multiplying one number by another will produce the same result as dividing the first number by the reciprocal of the second. For instance,

$$4 \times 3.1416 = 4 \div 0.3183.$$

Reciprocals are frequently used to avoid division as multiplication is a shorter and easier process. For instance, it is desired to divide 32 by 2.5. The reciprocal of 2.5 is 0.4 and

$$32 \times 0.4 = 12.8$$

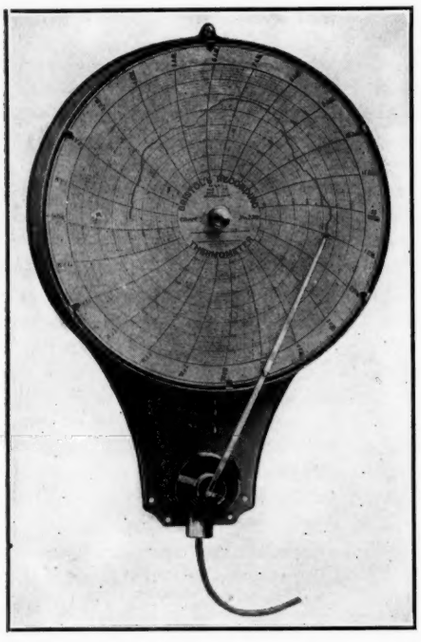
is shorter than long division.

# New Power House Equipment

*What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news*

## Bristol's Compensated Gas Filled Recording Thermometers

During the last fifteen years, Bristol recording thermometers have been constructed in various different forms, depending for their operation on the expansion of a liquid, the expansion of the vapor of a liquid or the expansion of a gas. These thermometers have been used for ranges of temperature up to 800 degrees Fahrenheit, but the model equipped with flexible connecting tube between the sensitive bulb and recording instrument and depending for its operation on the expansion of a vapor or a gas has not until recently been adapted for recording the lower ranges of temperature.



NEW BRISTOL RECORDING THERMOMETER

A new compensated gas-filled recording thermometer has recently been developed for recording the lower ranges of temperature, such as atmospheric temperature, temperatures of water, temperatures of brine in refrigeration systems, etc., and found satisfactory in numerous tests. These thermometers are equipped with a patented compensating device which automatically corrects for changes of temperature at the recording instrument.

The thermometers are equipped with a sensitive bulb and flexible capillary connecting tube and a patented pressure tube, the sensitive bulb and flexible connecting tube and spiral pressure tube all being filled with an inert gas under pressure. Changes of temperature at the sensitive bulb cause corresponding changes in the pressure of the confined gas and these changes in pressure are measured and recorded by the recording instrument. The sensitive bulb is usually about 10 inches long and ¾ inch in diameter and the volume of gas contained in this sensitive bulb is very large in proportion to the volume of gas contained in the fine capillary connecting tube between the sensitive bulb and the recording instrument, thus making the error due to changes of temperature along the connecting tube negligible.

The important new feature of this thermometer is the patented compensating attachment for the spiral pressure tube, since a thermometer equipped with this compensator gives the same readings or record when the temperature at the recording instrument changes as it would if the temperature at the recording instrument remained constant. The need for such a compensator can be illustrated by the application of a recording thermometer for recording temperature of brine in a refrigeration system. The temperature of the atmosphere at the point where the recording instrument was installed might change, although the temperature of the brine at the point where the sensitive bulb was installed remained constant, and a recording thermometer for brine temperature should, of course, be so constructed that it would be affected only by changes of temperature at the sensitive bulb.

This instrument is manufactured by the Bristol Company, Waterbury, Conn.

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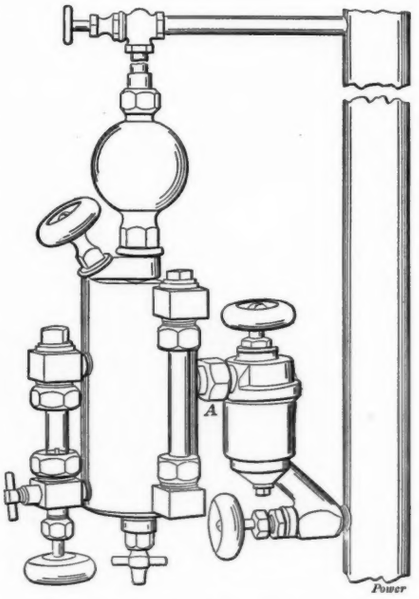
If the wood handle has been broken from a monkey wrench, a serviceable substitute can be made by slipping a piece of hose over the wrench, then filling the hose with babbitt.

## Graphoil Lubricator

The illustration shows the manner in which this lubricator is attached to a hydrostatic lubricator. The index connection *A* of the lubricator is made in various ways, so as to fit the connections of the different makes and sizes of oil lubricators.

The shutoff valve of the hydrostatic lubricator is dispensed with and the vertical and horizontal vapor pipes are changed slightly in length.




GRAPHOIL LUBRICATOR

When used in connection with mechanical or simple systems of lubrication, the oil pipes are connected to the inlet connection *A* of the graphoil lubricator. This device is made by C. C. Stilwell & Co., 1215 Filbert street, Philadelphia, Penn.

---

A curious accident interrupted the operation of the Hudson & Manhattan power station a short time ago. The fine soot and dust from the back connections had been discharged and allowed to accumulate in the fan room beneath the boilers, and had been drawn by the fans into the air ducts and deposited as a coating of carbon upon their inside surfaces. In some unexplained manner this carbon took fire, and urged by the blast of the fans developed such a heat that the ducts were twisted all out of place, and the entire draft-producing mechanism of the station put out of business.

## Features of Plant at Kodak Park Works

From the description of the oil-storage system used at the Kodak Park works embodied in the article under the above caption in the January 17 issue, the form of oil report shown herewith was inadvertently omitted.

K P 1782

OIL REPORT FOR.....19

| Departments. | Engine Oil Gals. | Cylinder Oil Gals. | Water White Gals. | Grease Pounds. | Cost For This Mo. | Cost For Average of Mont's. |
|---|---|---|---|---|---|---|
| Engines in No. 31 | | | | | | |
| " " No. 1 | | | | | | |
| Air Compressor | | | | | | |
| Millwrights | | | | | | |
| Chemical Plant | | | | | | |
| Roll Coating | | | | | | |
| " Power | | | | | | |
| Motor Oiling | | | | | | |
| Boiler Room | | | | | | |
| Conveyers | | | | | | |
| Miscellaneous | | | | | | |
| Total | | | | | | |

Cylinder Oil @ Per Gal.

Engine " @ " "

## Isolated Plant Movement Permanently Organized

A fair start in the movement toward rescuing the isolated plant from the invasion of the central station was made at a meeting held Monday evening, January 16, at the United Engineering Societies' building, 25 West Thirty-ninth street. The attendance was large and represented the interests of the manufacturers and supply men, the consulting engineers and the operating engineers. It was voted to make the organization permanent and a committee was appointed to draw up a constitution and by-laws, the object of the organization being to collect facts and data through mutual cooperation and thus make possible a concentrated effort to advance the interests of the isolated plant.

It was suggested that the membership be divided into two classes, members and associates, the former to be made up of those who would receive the greatest pecuniary benefit from the campaign, such as manufacturers and consulting engineers, and the latter to include the operating engineers and property owners. While the latter would have equal representation in the movement, they would not be called upon to subscribe so heavily as the former. This contention is justified by the fact that the majority of engineers already pay dues in a number of organizations, and making the dues in this one light, would attract a larger membership of operating engineers.

At the next meeting, to be held in the same rooms on January 30, the constitution will be acted upon and permanent officers elected.

## NEW PUBLICATIONS

The second edition of BULLETIN No. 4 of the Canadian Department of Mines is just out. The title of this work is "Investigation of the Peat Bogs and Peat Industry of Canada during the Season of 1909-10." The author is Aleph Anrep, Jr., peat expert for the Canadian government.

Reports are given on various peat bogs located in the eastern section of the Dominion, including the bog at Alfred, owned by the government. A complete description of the peat plant at the bog, together with numerous illustrations, is also given.

The bulletin is accompanied by eleven plates illustrating the Alfred bog and the equipment of the peat plant.

DYNAMO BUILDING FOR AMATEURS. By Arthur J. Weed. Published by the Norman W. Henley Publishing Company, New York, 1910. Eighty-three pages, 5x7½ inches; 64 illustrations. Price, cloth $1; paper 50 cents.

The problem of designing and building a 50-watt direct-current dynamo is taken up in detail; dimensioned working drawings are given for each piece of machine work and all important operations are illustrated. With the exception of three small castings, all the parts can be made on a small foot lathe.

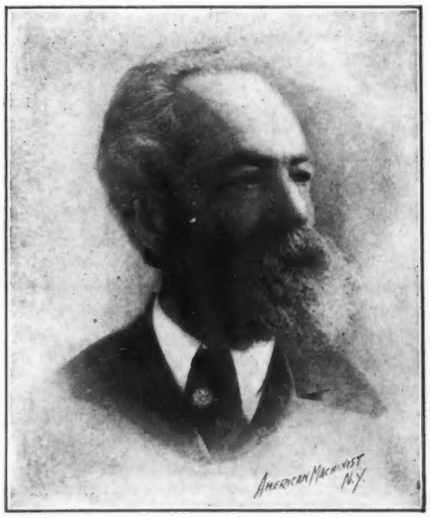
The treatise should prove both instructive and useful for the amateurs and students in manual-training schools as this little machine embodies the same principles as found in larger machines. When used as a motor in connection with a set of batteries it will drive a small drill press, lathe or sewing machine.

## OBITUARY

Charles Hill Morgan, prominent as a mechanical engineer and manufacturer, died at his home in Worcester, Mass., January 10. Mr. Morgan was born at Rochester, N. Y., Jan. 8, 1831, of New England parentage. His father was a mechanic and from him the son received that love of machinery and mechanical engineering which has been one of his most remarkable characteristics.

His first invention of note was a system of designing and constructing cam curves for looms. In 1868 he was made general superintendent of Washburn & Moen Manufacturing Company, and for eleven years was one of the company's directors. During his service with this company he improved the continuous rod-rolling mill, designed and originally constructed by George Bedson, of Manchester, Eng.

Nine years after the construction of




CHARLES HILL MORGAN

the Bedson mills, a third mill from new designs furnished by Mr. Morgan was built on the Belgian and continuous plans. This mill, the result of Mr. Morgan's studies, was known as the combination mill. The third improvement was the invention by Mr. Morgan of an automatic rod reel of the pouring type.

This was completed and gave a successful test in March, 1886. The automatic "laying" reel, now in common use in nearly every rod mill in the world, was the joint invention of Mr. Morgan and F. H. Daniels, another inventor of Worcester.

After 23 years of continuous service with the Washburn & Moen Company, Mr. Morgan resigned his position as general superintendent in 1887. He had previously founded the Morgan Spring Company, which came into existence in 1881, and now devoted his entire attention to its development. From the manufacture of steel springs only, the scope

of the business was enlarged into a general wire-mill business.

Four years later, in 1891, the Morgan Construction Company was incorporated to manufacture rolling-mill equipment and wire-drawing machinery. The work of Mr. Morgan and his associates in this company has been most successful and their designs of machinery have been widely adopted.

Besides his executive work, Mr. Morgan found time to become interested in the Worcester Polytechnic Institute, with which he has been connected in an official capacity for many years. He was, up to the time of his death, a trustee of the corporation, as well as being one of the active workers on the shop committee of the Institute.

He became a member of the American Society of Mechanical Engineers in 1881, the year following the society's establishment. He served as manager from 1884 to 1887, and was honored by an election as president of that society for the term 1899-1900. He was also a member of the American Institute of Mining Engineers.

While an engineer of exceptional ability and wide-spread influence, he has always been unassuming and never made the least effort to obtain recognition. He had a large circle of friends in Europe, where he spent much time in travel. In 1900 Mr. Morgan was elected to honorary membership in the Société des Ingenieurs Civil de France, and he was for years a member of the British Iron and Steel Institute.

His principal monument is the large number of young men he has helped. He was never too busy to see a young man and none ever left his presence without being richer and stronger in ambition and courage.

# NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

### PRIME MOVERS

GAS ENGINE. Henry K. Holsman, Chicago, Ill. 980,263.

INTERNAL COMBUSTION ENGINE. Henry L. F. Trebert, Rochester, N. Y. 980,366.

ROTARY ENGINE. William Birrell and James Birrell, Carbonado, Wash. 980,402.

GAS ENGINE. Otto J. Kirchen, Hancock, Mich. 980,423.

HYDRAULIC ENGINE. August Sundh, Yonkers, N. Y. 980,449.

ROTARY CYLINDER EXPLOSION ENGINE. Clyde J. Coleman, New York, N. Y., assignor to Rockaway Automobile Company, Rockaway, N. J., a Corporation of New Jersey. 980,491.

INTERNAL COMBUSTION ENGINE. Joseph S. Cortelyou, Brooklyn, N. Y. 980,494.

STEAM TURBINE. Ellis F. Edgar, Woodbridge, N. J. 980,504.

ROTARY INTERNAL COMBUSTION ENGINE. Eric Harald Ewertz, Wollaston, Mass. 980,506.

INTERNAL COMBUSTION ENGINE. Olof Ohlsson, Södertelje, Sweden. 980,552.

TURBINE. Joseph Knight, Holyhead, Anglesey, England. 980,644.

WATER WHEEL. Frederick Overfield, Cornwall, N. Y. 980,666.

WATER WHEEL. William C. Turner, Casey, Ill. 980,708.

ROTARY ENGINE. Paul Glamzo, New York, N. Y., assignor of one-half to Anton Razutocitch, Brooklyn, N. Y., and one-fourth to Baltrus S. Yankaus, New York, N. Y. 980,771.

INTERNAL COMBUSTION ENGINE. Otto Kraus, New York, N. Y., assignor to Kraus Engine Company, a Corporation of New York. 980,801.

### BOILERS, FURNACES AND GAS PRODUCERS

FIRE GRATE. Ebenezer Hall-Brown, Kelvinside, Glasgow, Scotland. 980,247.

GRATE. James Walp, Allentown, Penn., assignor to Clara C. Walp, Allentown, Penn. 980,370.

GAS PRODUCER. Charles F. Miller, Pittsburg, Penn., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania. 980,660.

### POWER PLANT AUXILIARIES AND APPLIANCES

LUBRICATING SYSTEM. Leon Alleman, Rochester, Penn. 980,178.

PUMP VALVE. John J. Ballard and Frank W. Parsons, Newark Valley, N. Y. 980,184.

WATER-LEVEL REGULATOR. Joseph E. De Bisschop, New Britain, Conn. 980,214.

SELF-CENTERING SHAFT PACKING. Edmund H. Farquhar, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 980,231.

PIPE COUPLING. John N. Goodall, Portsmouth, N. H., assignor, by mesne assignments, to Goodall Manufacturing Company, a Corporation of Maine. 980,245.

TURBINE BUCKET. Ernst Kallberg, Berlin, Germany, assignors to General Electric Company, a Corporation of New York. 980,283.

DRAFT REGULATOR. Theodore G. Meas, Lansing, Mich. 980,317.

OIL-CAN INDICATOR. Charles Scurlock, Pasadena, Cal. 980,348.

HOSE CONNECTION. Ira H. Spencer, Hartford, Conn., assignor to the Spencer Turbine Cleaner Company, Hartford, Conn., a Corporation of Connecticut. 980,355.

BLOWOFF VALVE. Anthony Nicholas Anderson, Albany, Ga., and Frederick W. Frank, Wilkes-Barre, Penn. 980,392.

GOVERNING MECHANISM FOR ELASTIC FLUID TURBINES. John G. Callan, Nahant, Mass., assignor to General Electric Company, a Corporation of New York. 980,487.

JOURNAL-BOX LUBRICANT DEVICE. Charles B. Coon, Evanston, Ill. 980,492.

DEFLECTOR FOR OIL BURNERS. Frederic A. Curtis, Toledo, Ohio, assignor, by mesne assignments, to the Steel Mantle Light Company, Toledo, Ohio, a Corporation of Ohio. 980,497.

TURBINE BUCKET. Edwin W. Rice, Jr., Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 980,563.

VALVE. Walter E. Barnes, Malden, Mass. 980,585.

METALLIC PACKING. Charles O. Bulock, Cleveland, Ohio, assignor to the H. W. Johns-Manville Company, Cleveland, Ohio, a Corporation of New York. 980,594.

MEANS FOR LUBRICATION OF WRIST PINS. John K. Campbell, Hartford, Conn. 980,597.

ROD PACKING. Parmer Dorsey, Hutchinson, Kan. 980,617.

WATER-LEVEL CONTROLLER. Forest A. Ray, Boston, Mass. 980,675.

STEAM TRAP. Charles E. Squires, Cleveland, Ohio. 980,694.

MOUNTING FOR FURNACE DOORS. George H. Cushing, Westfield, Mass., assignor to the H. B. Smith Company, Westfield, Mass., a Corporation. 980,764.

BOILER FURNACE. Gustav De Grahl, Wilmersdorf, near Berlin, Germany. 980,772.

FIRE DOOR FOR BOILER FURNACES. Gustav De Grahl, Zehlendorf, near Berlin, Germany. 980,773.

### ELECTRICAL INVENTIONS AND APPLICATIONS

SYNCHRONOUS DYNAMO ELECTRIC MACHINE. Jens Bache-Wiig, Edgewood Park, Penn., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 980,183.

ELECTRIC SWITCH. Arthur C. Eastwood, Cleveland, Ohio, assignor to the Electric Controller and Manufacturing Company, Cleveland, Ohio, a Corporation of Ohio. 980,221.

ELECTRIC SIGNALING APPARATUS. Roy A. Wilhite, Indianapolis, Ind. 980,380.

MOTOR-CONTROLLED SWITCH. Alfred James Barlow, Tottenham, England, assignor of two-thirds to Electromotor Equipment Company, Ltd., London, England. 980,475.

# ENGINEERING SOCIETIES

### AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Col. E. D. Meier; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

### AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

### NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff; sec., T. C. Martin, 31 West Thirty-ninth St., New York.

### AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

### AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next meeting to be held September, 1911, in Boston, Mass.

### WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

### ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

### AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City.

### NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio.

### AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

### NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill.

### INTERNAL COMBUSTION ENGINEERS' ASSOCIATION.

Pres., Arthur J. Frith; sec., Charles Kratsch, 416 W. Indiana St., Chicago. Meetings the second Friday in each month at Fraternity Halls, Chicago.

### UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

### OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; acting sec., Charles P. Crowe, Ohio State University, Columbus, Ohio. Next meeting, Youngstown, Ohio, May 18 and 19, 1911.

### INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

### INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

### NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.

# Moments with the Ad. Editor

*A department for subscribers edited by the advertising service department of Power*

There's an interesting point to be drawn from the play "Chantecler" which was recently produced in Paris.

The play produced a sensation because it is a distinct novelty—the dramatization of a barnyard and its inhabitants, with the actors dressed as fowl, dogs, etc.,—and because its author chose for his theme the prosaic animal-life of the farm.

The plot of the play is simple. The rooster, Chantecler, is regarded as a sort of demi-god because it is believed that he, by crowing each morning, makes the sun rise.

He, himself, firmly believes that if he did not crow the sun would not rise.

A Hen Pheasant, pursued by a hunter, rushes into the barnyard for protection. She charms Chantecler and finally induces him to go with her to the forest. He does so, oversleeps himself, and the sun rises without his call. Deprived of his dignity and power, he returns to the simple life of the farmyard.

A New York paper says, "One of the finest thoughts of the play is when Chantecler, forced to admit that his crow does not cause the sun to rise, declares that at least his crow proclaims that the sun has risen!" And there is the point.

The rooster is the advertising manager of the barnyard.

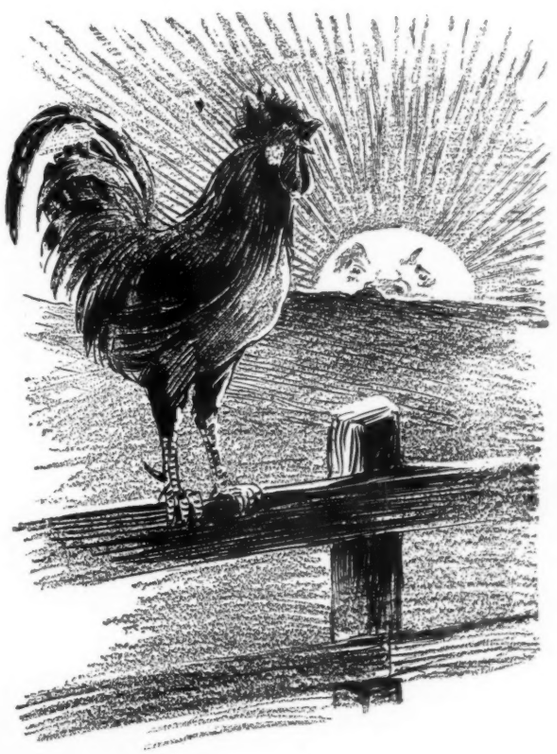
Reversed, the advertising manager is the rooster of the manufacturer.

His is not the duty of producing the goods but of telling about them.

It's a poor rooster who hasn't got the spurs to back up his crow.

And it's a weak crow he puts up when he hasn't got the goods to crow about.

No advertising writer was ever born who could put up a strong, convincing and able argument for an article that he himself did not believe in.



The first business of a manufacturer who trusts his advertising writing to someone else is to convert the writer—and most writers are pretty skeptical.

You see, the writer must produce definite and permanent results to make good. He knows that unless the article is right the results will not come or, if they do, they'll only be temporary; so, he writes with or without inspiration, depending on the goods he writes about.

Which is just one more reason added to the many why it does not and cannot pay to advertise poor goods.

The whole tendency of advertising is to throw light from every angle onto the article being advertised.

There is the manufacturer who must make certain claims and live up to them. There is the buyer who is looking for defects and quickly points them out so that they may be remedied. There is the competitor ready to combat any mis-statements. There is the advertising manager who must *believe* in the article or fail to write convincing advertising. There is the square publisher who will not permit questionable advertising in his paper. There is the whole advertising world continually working toward the goal of truth and sincerity in advertising.

All of these things hooked up together mean that the buyer can put his faith and trust in advertised goods in reputable papers and buy them with a full measure of confidence that they will live up to the claims made for them.

Advertising is that Chantecler which does not invent nor manufacture new devices for the use of mankind, but which proclaims their advent to a world which needs them.

What is the good of *unknown* good?

# BUSINESS ITEMS

The Cling-Surface Company, Buffalo, N. Y., is getting out an attractive calendar for distribution among members of the National Association of Stationary Engineers. The mounting of the calendar is 11x17 inches, and shows typical belting illustrations where Cling-Surface is used to advantage. Copies will be mailed upon request as long as the limited supply lasts.

The Michel-Kurze Company, with offices in the Hudson Terminal buildings, New York, has just been organized to do photo retouching and illustrating of machinery subjects. The business will be managed by A. Eugene Michel, associate member, American Society of Mechanical Engineers, and the staff of artists will be in charge of Wm. F. Kurze, who was art director of the Scientific Engraving Company during the past four years.

The Dearborn Drug and Chemical Works, which has distributed its feed-water treatment and lubricants through an agency in the Philippines for the past two years, has decided to open its own branch office and warehouse in Manila, and F. O. Smolt, who has been connected with mining propositions since his graduation in chemistry from the University of Illinos in the class of '91, has become connected with the Dearborn company, and sailed on January 7 for Manila, to take charge of this work, under the supervision of E. C. Brown, manager of the foreign department of the Dearborn company. Mr. Brown has spent most of the past two years in Japan, China and the Philippines, investigating steam plant and railroad conditions in the interests of the Dearborn products, and is still there, having made selling connections at Tokyo, Tientsin, Hongkong and Shanghai.

# NEW EQUIPMENT

Norwich, Conn., will establish a new pumping station.

Musselshell, Mont., will install a waterworks system.

Harriston, Ont., will install a new waterworks system.

Rutland, Mass., will install an electric-lighting plant.

West Brookfield, Mass., will expend $30,000 for a water system.

Waterloo, Ont., will spend $50,000 on an electric-lighting plant.

Chaffee, Mo., will construct waterworks. J. M. Massengill, mayor.

The plant of the Seaford (Del.) Ice Company was destroyed by fire.

The Glendale (Ariz.) Ice Company will build an ice-making plant.

St. Catherines, Ont., will spend $180,000 improving its waterworks plant.

The Shelbyville (Del.) Electric Light and Ice Company is making additions.

The Ottawa (Ont.) Electric Railway Company is erecting a new power house.

The Stroh Brewing Company, Detroit, Mich., will erect a two-story boiler house.

The J. P. Renton Company, Lynn, Mass., will install a steam engine and boiler.

The E. I. Stanton Company, Spokane, Wash., will erect a large packing plant.

The British Columbia Electric Company will build a power plant at Elko, B. C.

The Southern Pacific Railroad is preparing plans for a power station at Berkeley, Cal.

The Belle Fourche (S. D.) Creamery Company will erect a $10,000 cold-storage plant.

The Seymour Power and Electric Company will locate a plant at Bowmanville, Ont.

W. H. McElwain Company, Manchester, N. H., will erect a new central power station.

Hoyt Brothers, Ware, Mass., will purchase a 50-horsepower portable engine and boiler.

A new engine is to be installed in the Dover, Del., electric-light and pumping station.

The Water Department, Eveleth, Minn., is said to be considering the purchase of a new pump.

The Worcester *Telegram*, Worcester, Mass., is in the market for a motor-driven sump pump.

The Tuolumne River Power Company, Groveland, Cal., will make extensive improvements.

Engine room and boiler house, at the Bartlett mines, Gowganda, Ont., were destroyed by fire.

It is reported that Gas City, Ind., will rebuild its water and electric-light plant, recently burned.

The Heminway & Bartlett Silk Company, Watertown, Conn., is in the market for an engine indicator.

The Anheuser-Busch Brewing Company will build an addition to its cold-storage plant at Los Angeles, Cal.

The C. A. Eaton Company, Brockton, Mass., will build an addition to be used as a boiler and engine room.

The Royal Packing Company, Milton, Del., is making plans for the installation of a hydroelectric plant.

The International Bridge Company, Buffalo, N. Y., will erect a power house at Niagara and Wayne streets.

The Montgomery (Ala.) Light and Water Power Company will spend $350,000 in increasing its capacity.

The city of Mayfield, Utah, is considering the question of constructing waterworks. John M. Larson, city clerk.

The Gila River Power Company, Silver City, New Mexico, will build a 15,000-horsepower hydroelectric plant.

The city of Red Springs, N. C., has voted to issue bonds for the construction of waterworks and sewage system.

The power house of the Minneapolis (Minn.) General Electric Company was destroyed by fire. Loss, about $500,000.

The Northern Produce Company, Guero, Tex., will double its cold-storage facilities and install a 30-ton ice plant.

Moberly, Mo., is contemplating the erection of an electric-light plant. L. G. Knapp & Co., Kansas City, engineers.

The Beverly Investment Company, Beverly, Wash., will construct a pumping plant of 8,000,000 gallons capacity.

The city of Opelousas, La., will install additional equipment in its electric-light plant. Armas Durio, superintendent.

N. I. White is contemplating the installation of an electric-light plant (gasolene operated) at Ellenbury Depot, N. Y.

E. B. Moore, 57 President avenue, Quincy, Mass., will purchase a 150-horsepower steam boiler and 800-foot compound air compressor.

The city of Lexington, Va., will vote on the issuance of $75,000 bonds to increase its water supply. Samuel B. Walker, Jr., mayor.

The power plant of the Lorain Coal and Dock Company, at Blaine, Ohio, was almost totally destroyed by an explosion. Loss, $10,000.

The city of Georgetown, Tex., has purchased the electric-light plant and waterworks and will spend about $32,000 on improvements.

The Bristol & Plainville Tramway Company is planning to make changes at its power plant in Bristol, Conn. J. E. Cockings is superintendent.

The city council, Logansport, Ind., is said to be considering the question of purchasing a new pump for the waterworks of 6,000,000 gallons daily capacity.

The Maine & New Brunswick Electrical Power Company, St. John, N. B., will build a new line at Grand Falls, where a large power plant will be located.

E. E. Goff, of Portland, Ore., has applied to the city of Camas, Wash., for an electric-light franchise. Contemplates the erection of a hydroelectric plant on the Washougal river.

The Augusta Aiken Railway and Electric Company will purchase through the J. C. White Company, of New York, power-house equipment, including turbines, motor generators, etc.

The Boise (Idaho) Power, Light and Traction Company has been incorporated with $1,000,000 capital and is preparing to erect a 5000-horsepower hydroelectric plant on the Payette river.

The North Baltimore (Ohio) Service Company has been organized with $30,000 capital to erect and operate a gas and electric plant, by Arthur J. Darton, Ralph S. Holbrook, W. L. Holbrook, etc.

It is reported the Cedar Rapids & Iowa City Railway and Light Company will erect two new power stations, one at Iowa City and the other at North Liberty. Wm. G. Dows, Cedar Rapids, general manager.

The Weimer (Tex.) Water, Light, Ice and Cold Storage Company, recently organized, has taken over the electric-light plant and will make improvements. Will install waterworks, ice and cold-storage plant.

New equipment will be installed at the plant of the Trumbull Electric Company, Plainville, Conn., including one 150-horsepower engine, direct connected to a 100-kilowatt generator, one 100-horsepower return-tubular boiler, feed-water heater.

# NEW CATALOGS

Hawkes Boiler Company, Chicago, Ill. Booklet. Heating boilers. Illustrated, 20 pages, 3½x6½ inches.

Thermoid Rubber Company, Trenton, N. J. Booklet. How to Cut Gaskets. Illustrated, 24 pages, 3½x6 inches.

The Jeffrey Manufacturing Company, Columbus, Ohio. Catalog No. 26A. Mine fans. Illustrated, 36 pages, 6x9 inches.

Henry W. Buhler, 251 Causeway street, Boston, Mass. Pamphlet. Kilgour boiler setting. Illustrated, 12 pages, 6x9 inches.

The Bristol Company, Waterbury, Conn. Bulletin No. 130. Indicating and recording electric pyrometers. Illustrated, 56 pages, 8x10½ inches.

American Huhn Metallic Packing Company, 410-416 East Thirty-second street, New York. Catalog. Huhn packing. Illustrated, 20 pages, 6x9½ inches.

# HELP WANTED

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Thoroughly competent steam specialty salesman: one that can sell high-grade goods. Address "M. M. Co.," POWER.

WANTED—Experienced steam fitter foreman for manufacturing plant; state age, reference and salary expected. Address "CX," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn street, Chicago.

SALES AGENTS to sell steam turbine blowers, feed water regulators, ventilating fans, pumps, etc.; guaranteed territory; commission. Wing, 90 West St., New York City.

# SITUATIONS WANTED

***Advertisements under this head are inserted for 25 cents per line. About six words make a line.***

WANTED—Position in electric plant by young married man with four years' experience; city with chance for school preferred. Box 360, POWER.

ENGINEER, young man, familiar with gas engines and electrical machinery, power plant and factory experience; references from present employer. Box 361, POWER.

SITUATION WANTED by a young man; three years' experience in steam engineering; good mechanic; strictly temperate; references. Wm. M. Johnson, Jr., Moosups, Conn.

ENGINEER, ten years' experience in power and pumping plants, desires change; full charge of moderate sized plant; West preferred; first-class license. Box 474, Lander, Wyoming.

WANTED—Position by engineer who can do things, with concern who appreciates worth and ability; unquestionable reference. H. R. Rockwell, C. E., Mt. Vernon Car Mfg., Mt. Vernon, Ill.

POSITION WANTED as assistant engineer of small plant, by young man, graduate of Highland Park College of Steam Engineering; two years' experience; good references. Box 359, POWER.

ENGINEER, ten years' experience, desires steady position; married; have chief engineer license, stationary and marine; no experience on ice machinery. 115 E. Montgomery Ave., Allegheny, Penn.

STATIONARY ENGINEER wants position; now employed; seven years' experience with heavy duty gas engines; A-1 electrical operator; temperate, married; age 33; best references. Box 362, POWER.

CHIEF ENGINEER of considerable all-around experience, erecting and operating, medium and large steam, electric, refrigerating and waterworks plants, desires position; age 40. Box 355, POWER.

POSITION BY YOUNG married man as draftsman, with chances for advancement, with steam engine and boiler concern; has seven years' drafting and three and one-half years' boiler shop experience. Box 357, POWER.

YOUNG MAN who holds Massachusetts first-class license and is also eligible as State inspector of boilers, wishes position as engineer; ten years' experience in electric light, power and mill plants. Box 356, POWER.

WANTED—Position as engineer by young married man, experienced in operating alternating- and direct-current generators, Corliss and automatic engines, return tubular and water tube boilers; references. Address Box 354, POWER.

ENGINEER, New Jersey license, 40 years old, married, desires steady position; able to operate and repair dynamo, ice or factory machinery; many years' experience and best of references; at present employed as superintendent of apartment house; willing to go anywhere. Box 363, POWER.

YOUNG MAN, now employed, with executive ability and experience in the administration of a machinery and supply business, desires position with machinery firm, or as manager or assistant manager of branch house, where the conditions are healthful and congenial; preferably the South or West; if you need a competent man, address Box 358, POWER.

# MISCELLANEOUS

***Advertisements under this head are inserted for 25 cents per line. About six words make a line.***

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

THE ANNUAL MEETING of the stockholders of the Hill Publishing Company, for the election of directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the offices of the company, in the Hallenbeck building, 497-505 Pearl street, Borough of Manhattan, New York City, N. Y., on Tuesday, January 31, 1911, at 12 o'clock noon.

Dated, New York City, December 9, 1910.
Robert McKean, Secretary.

# FOR SALE

***Advertisements under this head are inserted for 25 cents per line. About six words make a line.***

FOR SALE—Small screw cutting lathe, chuck and tools; fine condition; bargain. South Bend Machine Co., South Bend, Ind., 424 Madison St.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

ONE BUCKEYE cross compound engine, 24x46x36, 114 revolutions per minute, complete with rope sheeve, flywheel and about 1500 feet practically new transmission rope; and Deane jet motor driven condenser; apparatus in best operating condition; a bargain for any one needing same. Peoples Power Co., Rock Island, Ill.

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Every employer likes to see economy practiced in his plant.

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is installed either in the engine room *or in the manager's office.*

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And if your boiler is being tended properly, every daily chart will record "economical firing."

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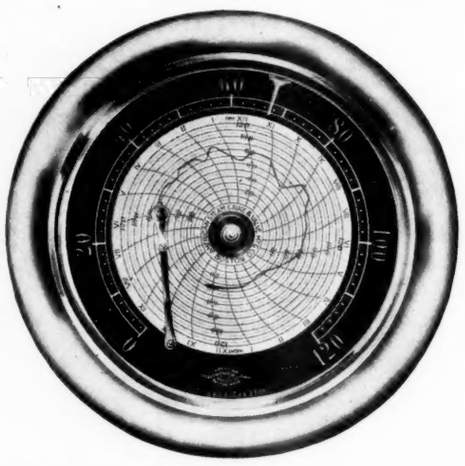

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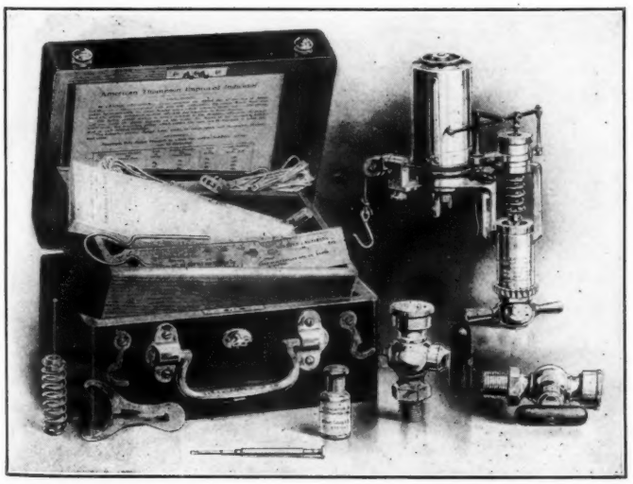

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# Why a Cochrane Heater is better than a closed heater

## IT IS BETTER TO BUY A COCHRANE HEATER THAN TO WISH YOU HAD

*The manager of a paper mill to whom we made a proposition on a Cochrane Heater some three or four years ago, but who bought a closed heater, recently expressed the earnest wish that he had bought a Cochrane Heater instead.*

The closed heater has gone to pieces. That is, the tubes are corroded, and many have been replaced. There is trouble with leakage at the joints. Due to accumulations of scale upon one side, and grease upon the other side of the heating surface, the heat transmission is poor. After the heater had been in service some time it was impossible to obtain a high temperature of the feed water, although steam was escaping to atmosphere. Even when newly cleaned, the closed heater does not give a temperature higher than 180 or 190° F., although **the Cochrane Heater will give close to 210° F.** as long as there is sufficient exhaust steam available to heat the water.

And it takes less exhaust steam to bring the water up to 210° F. in a Cochrane Heater than in a closed heater, that is, to make 7 lbs. of hot feed water in a closed heater requires 7 lbs. of cold water and 1 ⅛-lbs. of steam, but in a Cochrane Heater 6 lbs. of cold water and 1 lb. of steam make 7 lbs. of boiling hot feed water; that is, **in the Cochrane Heater, the steam is condensed to pure distilled water and is added to the feed water.**

The corrosion of the closed heater was due to air and gases set free from the water by heating. **In the Cochrane Heater, such gases escape through the vent to atmosphere,** but in the closed heater they are pumped right through with the water to the boiler, to corrode the steam pipes and boiler tubes and shell. It is now a well recognized fact that corrosion of boiler tubes and plates does not occur unless there is air dissolved in the water, and with plenty of air dissolved in the water, even distilled water will corrode iron. The sure way of driving air and gases out of water is to heat it in a Cochrane Open Feed Water Heater.

The driving off of carbon dioxide from the water serves to convert the soluble bi-carbonates of lime and magnesia into the insoluble mono-carbonates, which precipitate in the heater, instead of passing on into the boiler. If there are sulphates, chlorides, nitrates or other elements which form "permanent" hardness, the functions of the Cochrane Heater can be extended to provide for softening by the use of a cheap and efficient reagent, that is, a Sorge-Cochrane Hot Process System can be installed.

If your boiler feed water is colder than 200° F., or if it forms scale in or corrodes the boilers, write to us, and we will send our several treatises on the "*Profitable Utilization of Exhaust Steam,*" and on the "*Heating and Softening of Boiler Feed Water.*"

Also if you will give us the necessary information we shall be pleased to suggest possible improvements to your boiler-feed-water heating or softening or water and oil separating equipment.

By the way, have you received a copy of our pamphlet "*What Scale Does to Boilers?*" Well worth reading, if you are looking after boilers.

## HARRISON SAFETY BOILER WORKS

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**Heaters and Purifiers, Feed Water**

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Griscom-Spencer Co.....105
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Hoppes Mfg. Co.....104
National Pipe Bending Co....105
Open Coil Heater & Purifier Co. .....104
Patterson & Co., Frank L....105
Robertson & Sons, Jas. L.... 75
Wheeler Mfg. Co., C. H..... 98
Whitlock Coil Pipe Co..... 79
Wickes Boiler Co.....108
Williams Tool Co.....104

**Heating and Ventilating Systems**

Green Fuel Economizer Co.... 80
Ohio Blower Co..... 13
Schutte & Koerting Co..... 78
Wing Mfg. Co., L. J..... 81

**Heating, Central Station**

American District Steam Co..100

**Hoists, Electric**

Allis-Chalmers Co.....113
Yale & Towne Mfg. Co..... 88

**Hoists, Gas Engine**

Foos Gas Engine Co.....113

**Hoists, Hand**

Yale & Towne Mfg. Co..... 88

**Hose, Metal**

American Metal Hose Co..... 94

**Hose, Rubber**

Diamond Rubber Co..... 93
Garlock Packing Co..... 9
Lagonda Mfg. Co.....3d cover
New York Belting & Packing Co. ..... 10
Peerless Rubber Mfg. Co..... 8
Pennsylvania Flexible Metallic Tubing Co..... 92

**Ice and Refrigerating Machinery**

Vogt Machine Co.....106
York Mfg. Co.....112

**Indicators, Ammonia**

American Steam Gauge and Valve Mfg. Co.....66 and 67

**Indicators, Flow**

Richardson-Phenix Co..... 94

**Indicators, Gas Engine**

American Steam Gauge and Valve Mfg. Co.....66 and 67
Schaeffer & Budenberg Mfg. Co. .....4th cover
Trill Indicator Co..... 99

**Indicators, Speed**

Schaeffer & Budenberg Mfg. Co. .....4th cover
Starrett Co., L. S..... 88

**Indicators, Steam Engine**

American Steam Gauge and Valve Mfg. Co.....66 and 67
Crosby Steam Gage & Valve Co. ..... 89
Robertson & Sons, Jas. L.... 75
Schaeffer & Budenberg Mfg. Co. .....4th cover
Trill Indicator Co..... 99

**Injectors**

Jenkins Bros..... 71
Lunkenheimer Co..... 4
Penberthy Injector Co..... 14
Robertson & Sons, Jas. L.... 75
Schutte & Koerting Co..... 78

**Lamps, Electric**

General Electric Co..97 and 118
Johns-Manville Co., H. W.... 77
Westinghouse Elec. & Mfg. Co.103

**Lathes, Foot Power**

Barnes Co., W. F. & John.... 93

**Lubricators, Cylinder**

Albany Lubricating Co..... 95
Detroit Lubricator Co..... 94
Greene, Tweed & Co., 96 and 4th cover
Griscom-Spencer Co.....105
Lunkenheimer Co..... 4
Manzel Bros. Co.....113
Richardson-Phenix Co..... 94
Robertson & Sons, Jas. L.... 75
Sterling Lubricator Co..... 96
Universal Lubricator Co..... 15

**Lubricators, Force Feed**

Lunkenheimer Co..... 4
Richardson-Phenix Co..... 94

**Mats and Matting**

Diamond Rubber Co..... 93
New York Belting & Packing Co ..... 10
Peerless Rubber Mfg. Co.... 8

**Metal, Bearing**

Allan & Son, A.....114
Leddell-Bigelow Co.....112
Magnolia Metal Co.....113

**Meters, Water**

Builders Iron Foundry.....106

**Micrometers**

Starrett Co., L. S..... 88

**Milling Machines, Portable**

Underwood & Co., H. B.....114

**Motors, Electric**

Allis-Chalmers Co.....113
American Engine Co.....116
General Electric Co..97 and 118
Ridgway Dynamo & Engine Co .....116
Sturtevant Co., B. F..... 77

**Motors, Water**

Lagonda Mfg. Co.....3d cover

**Oil and Grease Cups**

Albany Lubricating Co..... 95
Detroit Lubricating Co..... 94
Elliott Co..... 7
Keystone Lubricating Co.... 3
Lunkenheimer Co..... 4
N. Y. & N. J. Lubricant Co... 79
Richardson-Phenix Co..... 94
Schaeffer & Budenberg Mfg. Co. .....4th cover
Universal Lubricator Co..... 15

**Oil Burners**

Hammel Oil Burner Co..... 83
Lunkenheimer Co..... 4
Parson Mfg. Co..... 83

**Oil Reservoirs**

Burt Mfg. Co..... 18
Richardson-Phenix Co..... 94

**Oiling Systems**

Albany Lubricating Co..... 95
Burt Mfg. Co..... 18
Detroit Lubricator Co..... 94
Industrial Instrument Co.... 90
Lunkenheimer Co..... 4
Richardson-Phenix Co..... 94

**Oils**

Albany Lubricating Co..... 95
Dearborn Drug & Chemical Works ..... 5
Kellogg & Co., E. H..... 94
N. Y. & N. J. Lubricant Co... 79
Walton Co., F. S.....16 and 17

**Packing, Flange**

American Goetze-Gasket & Packing Co..... 80
Cancos Mfg. Co..... 92
Chesterton Co., A. W..... 92
Diamond Rubber Co..... 93
Eureka Packing Co..... 93
Garlock Packing Co..... 9
Greene, Tweed & Co., 96 and 4th cover
Jenkins Bros..... 71
Johns-Manville Co., H. W.... 77
National India Rubber Co... 94
New York Belting & Packing Co. ..... 10
Peerless Rubber Mfg. Co.... 8
Smooth-On Mfg. Co..... 6
Thermoid Rubber Co..... 11
Von Kokeritz & Co., R. G.... 78

**Packing, Hydraulic**

Cancos Mfg. Co..... 92
Chesterton Co., A. W..... 92
Diamond Rubber Co..... 93
Garlock Packing Co..... 9
Johns-Manville Co., H. W.... 77
Robertson & Sons, Jas. L.... 75
Schieren Co., Chas. A..... 86
Steel Mill Packing Co..... 93
Tripp Metallic Packing Co... 93
Von Kokeritz & Co., R. G.... 78

**Packing, Piston Rod**

American Goetze-Gasket and Packing Co..... 80
Cancos Mfg. Co..... 92
Chesterton Co., A. W..... 92
Diamond Rubber Co..... 93
Eureka Packing Co..... 93
Garlock Packing Co..... 9
Greene, Tweed & Co., 96 and 4th cover
National India Rubber Co.... 93
New York Belting and Packing Co..... 10
Peerless Rubber Mfg. Co..... 8

**Packing, Piston Rod**—*Cont.*

Power Specialty Co..... 92
Steel Mill Packing Co..... 93
Thermoid Rubber Co..... 11
Tripp Metallic Packing Co... 93
Von Kokeritz & Co., R. G.... 78

**Packing, Pump Valve**

Cancos Mfg. Co..... 92
Diamond Rubber Co..... 93
Von Kokeritz & Co., R. G.... 78

**Packing, Valve Stem**

Cancos Mfg. Co..... 92
Diamond Rubber Co..... 93
Greene, Tweed & Co., 96 and 4th cover
Tripp Metallic Packing Co... 93

**Pipe**

Ball & Wood Co.....114
Kellogg Co., M. W..... 90
National Tube Co..... 80

**Pipe Bending**

Ball & Wood Co.....114
Kellogg Co., M. W..... 90
National Pipe Bending Co....105
Whitlock Coil Pipe Co..... 79

**Pipe Clamp**

Simplex Engineering Co..... 89

**Pipe Coils**

National Pipe Bending Co....105
Whitlock Coil Pipe Co..... 79

**Pipe Cutting and Threading Machines**

Armstrong Mfg. Co..... 90
Bignall & Keeler Mfg. Co.... 90
Curtis & Curtis Co..... 89
Toledo Pipe Threading Mach. Co. ..... 85
Treadwell Co., M. H..... 80
Trimont Mfg. Co.....110

**Pipe, Riveted Steel**

Kennicott Co., The..... 88

**Piping, Blow**

Ohio Blower Co..... 13

**Piping, High Pressure**

Kellogg Co., M. W..... 90

**Planimeters**

American Steam Gauge and Valve Mfg. Co.....66 and 67
Robertson & Sons, Jas. L.... 75
Trill Indicator Co..... 99

**Plumbago**

Acheson Graphite Co., International ..... 96
Dixon Crucible Co., Jos..... 96

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Hoffman, Geo. W..... 94
Johns-Manville Co., H. W.... 77

**Publishers**

International Textbook Co.... 73
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**Pulleys**

Minneapolis Steel & Mchy. Co. 80

**Pumps, Air**

Blake & Knowles Steam Pump Works .....105
Cameron Steam Pump Wks., A. S. ..... 99
Deming Co..... 99
Du Bois Iron Works.....113
Wheeler Mfg. Co., C. H..... 98
Wilson, C. E..... 98

**Pumps, Centrifugal**

Alberger Condenser Co..... 98
Allis-Chalmers Co.....113
Deming Co..... 99
Wilson, C. E..... 98
Worthington, Henry R..... 99

**Pumps, Deep Well**

Cameron Steam Pump Wks., A. S..... 99
Wilson, C. E..... 98

**Pumps, Electric**

Du Bois Iron Works.....113
Westinghouse Elec. & Mfg. Co.103
Wilson, C. E..... 98

**Pumps, Oil**

Blake & Knowles Steam Pump Works..... 105
Burt Mfg. Co..... 18
Cameron Steam Pump Wks., A. S..... 99
Du Bois Iron Works.....113
Lunkenheimer Co..... 4
Manzel Bros. Co..... 94